Geotechnical Engineering Office, Civil Engineering and Development Department
The Government of the Hong Kong Special Administrative Region

GEO Technical Guidance Note No. 44 (TGN 44)
Assessment of Landslide Debris Impact Velocity for Design of Debris-resisting Barriers

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1. SCOPE

1.1 This Technical Guidance Note (TGN) supplements the guidance on the assessment of debris impact velocity for the design of rigid debris-resisting barriers and the design of flexible debris-resisting barriers using the force approach.

1.2 Any feedback on this TGN should be directed to the Chief Geotechnical Engineer/Standards & Testing of the GEO.

2. TECHNICAL POLICY

2.1 The technical recommendations referred to in this TGN were agreed by the GEO's Geotechnical Control Conference on 25 March 2015.

3. RELATED DOCUMENTS

3.1 GEO (2015). *Supplementary Technical Guidance on Design of Rigid Debris-resisting Barriers (GEO TGN 33).* Geotechnical Engineering Office, Hong Kong, 1 p.

3.2 Kwan, J.S.H. (2012). *Supplementary Technical Guidance on Design of Rigid Debris-resisting Barriers (GEO Report No. 270).* Geotechnical Engineering Office, Hong Kong, 88 p.

3.3 Kwan, J.S.H. & Cheung, R.W.M. (2012). *Suggestions on Design Approaches for Flexible Debris-resisting Barriers (DN 1/2012).* Geotechnical Engineering Office, Hong Kong, 90 p.

4. BACKGROUND

4.1 GEO Report No. 270 "Supplementary Technical Guidance on Design of Rigid Debris-resisting Barriers" (Kwan, 2012) recommends giving consideration to multiple phases of landslide debris impacting on barriers. The same consideration is suggested for design of flexible debris-resisting barriers if the force approach is adopted (Kwan & Cheung, 2012).

4.2 The prevailing design guidelines suggest applying the same design impact velocity to all phases. However, observations of local landslide cases and physical flume test results suggest that debris velocity varies along the length of landslide debris.

4.3 A review of the assessment of the design impact velocity as well as the design impact thickness has been carried out. This TGN promulgates the recommendations of the review.

5. TECHNICAL RECOMMENDATIONS

5.1 Multiple phases of landslide debris impacting on barriers should be considered in the design of rigid debris-resisting barriers and the design of flexible debris-resisting barriers using the force approach. The design debris impact velocity (and design boulder impact velocity as appropriate) of each phase of impact can be calculated using (i) the volume of debris deposition after each phase of impact, (ii) the cumulative debris volume hydrograph, and (iii) debris velocity hydrograph. The hydrographs refer to the conditions at the barrier location, established using landslide debris mobility analysis considering the free field situation.

5.2 The debris deposition wedge behind a barrier is taken to be triangular in shape for the purpose of calculating the debris volume of each phase stopped by the barrier (see Figure 1a). Based on the calculated deposition volumes of different phases, the time intervals of the phases are read off from the cumulative debris volume hydrograph (see Figure 1b). The debris velocity corresponding to each phase is then established based on the time interval from the velocity hydrograph (see Figure 1c). The velocity of each phase should be adopted to assess the landslide debris impact load. The debris deposition wedges shown in Figure 1a depict the deposition profiles which could appear during the filling up process of the barrier. They do not represent the final debris deposition profile, and thus not for calculation of the overall barrier retention capacity.

5.3 The design impact thickness of the n^{th} phase impact (denoted by h_n in Figure 1a) is assumed to be constant and should be taken as the larger of (i) the maximum thickness of landslide debris that would pass through the barrier location in the free field condition, (ii) a nominal thickness of 0.5 m, and (iii) the estimated thickness of the boulder accumulated front. Consideration of the abundance of boulders should be given when determining h_n. The design impact thickness in the first phase or the first few phases of impact could be controlled by the thickness of the boulder accumulated front while subsequent phases may not.

5.4 The following guidelines should be followed in determining the debris impact loads:

(a) the maximum debris velocity in each phase should be used to establish the design impact load of the corresponding phase,

(b) the design impact velocity of any phase should not be less than 70% of the maximum debris velocity obtained from the velocity hydrograph, and

(c) the landslide debris impact direction should be perpendicular to the barrier.

5.5 Impact loads due to debris flow (and isolated boulder(s) in debris as appropriate, subject to the abundance of boulders) hitting the very top of barriers and the effects of debris flow overtopping of the barriers should be assessed. The design debris velocity of the phase hitting the crest portion of the barriers and the design debris thickness stated in para 5.3 are relevant for the assessments.

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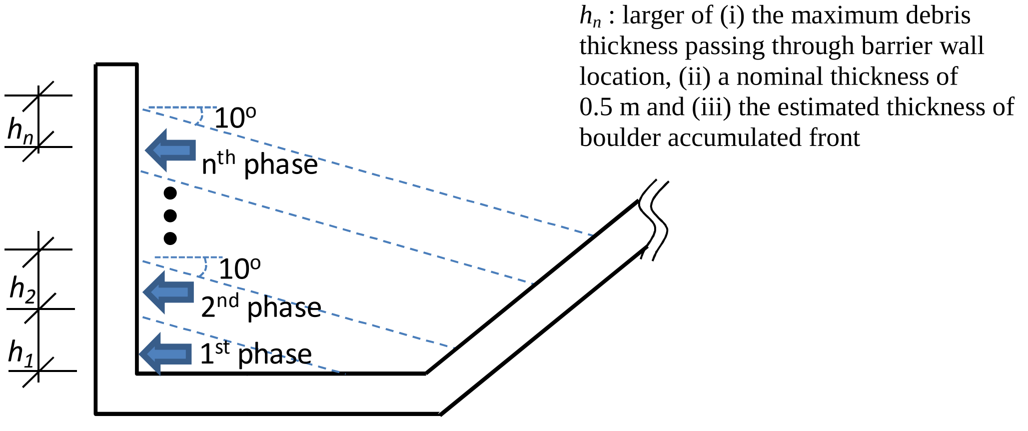
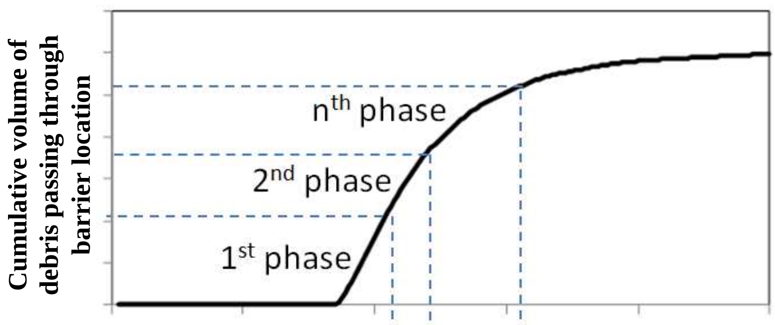
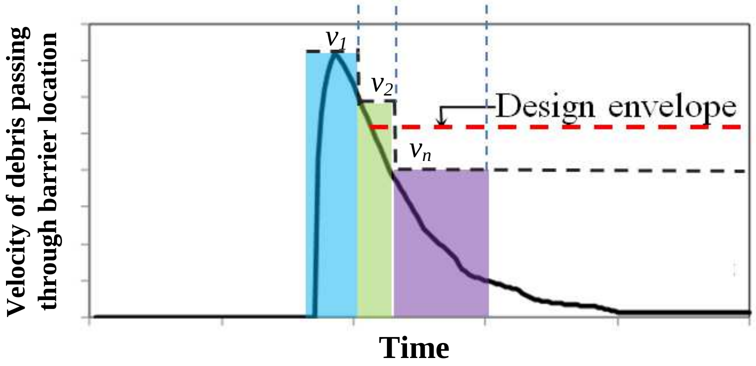
(a)



(b)



(c)



v_n = design impact velocity of the n^{th} phase ⊀ 0.7 maximum debris velocity of the hydrograph

Figure 1 Establishing impact velocity of each phase