Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2018-154-AC1, 2018

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Avalanche Impact Pressures on Structures with Upstream Pile-Up/Accumulation Zones of Compacted Snow" *by* Perry Bartelt et al.

Perry Bartelt et al.

bartelt@slf.ch

Received and published: 26 September 2018

Dear Peter,

Many thanks for your comment. We formulated our approach using papers discussing field scale impact experiments. We find it remarkable that nobody has applied your results in the last 10 years to evaluate measured impact pressures.

We developed our model using a completely different approach: Application of the work-energy theorem. We get comparable results. However, our approach leads to further insights into avalanche impact, that is not discussed in Chapter 11. These differences in derivation become important in understanding the overall problem.

The work theorem states that the change in kinetic energy ΔK is equal to the product of the force F (on the wall from pile-up) and the braking distance d of the avalanche mass stopped by the wall,

ΔK=F d.

Using the standard definition for impact pressure p = F/A

p=1/2 C_d Uˆ2

(where C_d = stress intensity factor; = density; U = approach velocity, A = cross-sectional area) we arrive at an interesting re-definition of the stress intensity factor:

C_d=(V/A)/d=l/d

where V is the volume stopped by the wall, with (l = V/A). Interestingly, the stress intensity factor (for pile-up) is simply defined as the length of incoming mass scaled to the braking distance. Of course, this is a crude approximation (we don't consider potential energy, true for an avalanche moving on a plane); however, it is equivalent to your treatment. We both take l=UΔt. For us, the braking distance is given by the compacted density _0 of the snow and mass conservation

d=1/2 (U- S ÌĞ)Δt=1/2 (1- /_0)UΔt.

The advantage of the work-energy approach is that we can divide up the incoming mass into a pile-up mass l(t) and a deflected mass (or splashed mass). Moreover, mass that is not piled-up, must be deflected. That is, l$\neq$ UΔt. In fact, we can define a l(t) that depends on the geometry of the pile-up zone – for example, wedges. For the engineer, defining l(t) then becomes the key problem in determining appropriate avalanche impact pressures. Knowing the pile-up geometry, we can predict the duration time of the pile-up force – the peaks in pressure and therefore dynamic magnification factors. An important aspect is that the time to pile-up is very short compared to the time the avalanche needs to flow by. Thus, in the general case we are confronted with two sources for the impact force – pile-up and deflection. This is true for both walls and thin objects. (Deflection requires invoking Newton's laws of changing momentum to find the force.)

The approach of invoking the work-energy theorem thus opens many doors to consider different impact situations, including the interpretation of experimental results. Frankly, it is impossible to interpret experimental measurements without knowing I(t). We think that it is very important for practicing avalanche engineers to be presented with basic, compelling and consistent explanations. Although your chapter is of great interest to us for several reasons, we intend to follow a different path and see where it leads.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2018-154, 2018.