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Slit-check dams for the control of debris flow

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Debris flows are paroxysmal events that mobilize, alongside water, huge quantities of sediment in a very short time, then with both solid and liquid huge discharges, possibly exceeding the capacity of the current torrent restoration works. In this respect, the climate change forcing cannot be ignored. In the majority of urbanized areas, that are generally the most vulnerable, there is often not enough space to create channelling works able to let the volumes pass through without overflowing.
The simplest, less expensive and most sustainable solution consists in reducing the peak solid discharge by creating storage areas upstream of the settlements, typically upstream of the alluvial fans, allowing for reduced works of canalization, that are compatible with the constraints imposed by the urbanization. The general idea consists in storing a part of the flowing solids during the peak of the hydrograph and releasing it in a successive phase or during minor floods.
For this purpose, and in order to optimize the solid peak discharge reduction, it is necessary that properly designed open-check dams, capable of inducing a significative sedimentation of the solid discharge only when this exceeds a design-threshold value, control the deposition basins. A correct design of the check dam is crucial in order to induce the sedimentation in the right amount and at the right moment: a too early sedimentation might fill the volume before the peak, like in the case of close-check dams, while a too weak sedimentation might not use the whole available volume. In both cases, the channelling works might not be sufficient to let all the flow pass through, compromising the safety of the settlement. To avoid this inconvenience, we propose the use of slit-check dams, whose efficiency has already been proved for bed load. Check dams are often designed only on the base of the designer's experience. Besides, even today it is often believed that the filtering effect of open check dams is exerted through a mechanical sieve, while it was proved that the retention of the solid material is rather due to a hydrodynamic effect induced by the narrowing of the section. Also in the case of debris flow, through proper balances of liquid and solid mass and energy it is possible to obtain a rational criterion for designing the width of the slit in order to obtain a sediment deposition of desired elevation for a given design discharge. In this way the use of the retention basin can be optimized in order to maximize the reduction of the debris flow peak discharge. Flume experiments were carried out in steady conditions at the University of Trento and confirmed with good agreement the prediction of the theory. As in the case of ordinary sediment transport, the clogging induced by the vegetal material represents the major problem for the operational reliability of this systems and needs therefore to be further investigated.