Fascines for riverbank stabilization : structural failure processes and design suggestions from physical modelling

Solange Leblois, Guillaume Piton, Alain Recking, André Evette

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Fascines for riverbank stabilization : structural failure processes and design suggestions from physical modelling

Solange Leblois[1], Guillaume Piton[2], Alain Recking[2], and André Evette[1]
[1]Inrae , Lessem, Grenoble, France (solange.leblois@inrae.fr)
[2]Inrae, Etna, Grenoble, France

Willow fascine is the soil bioengineering technique for riverbank stabilization the most frequently used in France. Made up of bundles of living branches fixed between stakes, the fascine presents various possible configurations, adaptable to each site. The structure, with high theoretical resistance, is implemented at the bottom of the riverbank joining the riverbed and the riverbank, which makes it subject to strong constraints. Terrain return of experience showed that 22 % of the fascines did not start or did not stand after few years. Punctual observations in the field do not give the possibility to understand the whole process behind fascines structural failure nor to test various fascine configurations over a short period of time. The study based on physical modelling (scale 1:25) describes how riverbanks with fascines are destabilized and develops which fascine design could better stand. The techniques are replicated on the extrados of three meanders created in the flume. Each bank protection technique undergoes the same flood hydrogram. Three various bank toe protection techniques are tested with and without geotextile to protect the rest of the bank. Bank toe without protection is confronted to designs of *(i)* fascines with one bundle, *(ii)* fascines with two bundles and *(iii)* ripraps with the thickness of the two bundles fascine. Bank pressure is measured continuously, the topography is established by photogrammetry before and after each experiment and direct observations are conducted. As first main result, the process of destabilization of riverbanks with fascines could be descripted. Scour holes, naturally occurring at meanders extrados, develop bellow the fascine level of implementation. The bank material initially stocked behind the fascine is than free to fall in the scour hole. The fascine ends up isolated in the river. Without contact to the substrate, the living material cannot start anymore. Moreover, consecutive to the scour holes development, the fascines stakes fall into the river leading to the fascine structural failure. As second result, between the three bank toe protection techniques tested, the fascine with two bundles and geotextile stabilized the best the bank. However, this strong configuration resulted with deeper scour holes at the bottom of the fascine. Finally as third result, with the sediment material used, the water pressure differential between the riverbank and the running water did not enhance any bank erosion. The destabilization of riverbank with fascines is mainly driven by natural morphologic river adjustment. Consequently, the fascine design could be adjusted as follow. *(i)* The bank slope must be reduced to its maximum to minimize the scour hole. *(ii)* The fascine must be deeply anchored by the stakes. *(iii)* The fascine toe, below the level of vegetation start, is preferentially reinforced by extra bundles, wood pieces or riprap, in order to confined the bank material.