

## CONCRETE OR STONE MASONRY FRAME WITH IN-PLANTED GRASS

Suburban and urban	River	Medium-cost	Riverbank erosion
DESCRIPTION			
<b>Measures</b>	This is a larger-scale alternative to concrete blocks, but the concrete or masonry frame is laid in situ and the internal area is then filled with suitable soil and planted with grass or other appropriate vegetation.		
<b>Location</b>	Suitable for urban waterways above the normal water level.		
<b>Design options and performance</b>	Vegetated concrete or stone masonry frames with grass inserts are used to control erosion control on the banks of rivers and waterways and are frequently used in Vietnam. They have a similar function to vegetated concrete blocks but since the spaces are much larger the soil needs to be protected with a bamboo or twine mesh to hold the soil in place while the plants establish.		
<b>Feasibility criteria</b>	<ul style="list-style-type: none"> <li>• <b>Technical design:</b> Before the construction of the frame, the bank is prepared according to the design slope, and any holes and irregularities are filled/removed. The framework structure is constructed during the dry season with concrete with rebar reinforcement or stone masonry and is placed in situ in a rectangular grid of shallow trenches which are excavated in the bank slope. Planting should take place at the start of the rainy season. A layer of bamboo or other biodegradable material is placed in the interior panels inside the frame and then the panels are filled with suitable soil for planting. The mesh holds the soil together while the root system of plants is developing.</li> <li>• <b>Soil media:</b> Any suitable growing soil.</li> <li>• <b>Soil slope:</b> Maximum slope where block systems should be used is 1.4.</li> <li>• <b>Surface cover:</b> Grass or other suitable vegetation is planted in the panels between the frames.</li> <li>• <b>Materials:</b> Wood panels for shuttering, concrete or stone and cement, soil and seeded grass or plants.</li> </ul>		
<b>Operation and maintenance</b>	The bank slope should be checked after each rainy season and any damage to the frame or vegetation repaired or replaced. During the summer growing season, the grass or vegetation should be cut back as required.		
<b>Cost and benefits</b>	This is a low to medium-cost measure especially if stone masonry is used and the stone is locally available. The benefits are that the permeability of the embankment is increased thus reducing		

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	runoff while protecting the slope from erosion. Once the vegetation becomes established, the embankment has a green natural look and a wildlife habitat is created.
<b>Design solution</b>	The concrete or masonry frame can be constructed several months before the planting which should take place at the beginning of the wet season. The framework should be constructed in panels each consisting of 4 rectangular openings. The dimensions of the panels will depend on the site conditions and the specific design considerations should be about 6 by 8 meters. A compressible joint filler, 10 mm thick should be placed between the panels. When the frame has cured the panels should be filled with suitable topsoil in preparation for the planting. Plants for planting should be prepared as “slips” which are clumps of grass or other vegetation including the roots wrapped in jute sacks and kept in shade for transporting to the site and planting on the same day. The slips should contain at least two buds and five roots with live growth.
<b>Environmental performance</b>	The use of vegetation in conjunction with hard civil engineering slope stabilization measures such as a concrete or masonry frame will increase the effectiveness of the structure and provide additional resistance to erosion. The layers of vegetation on the surface protect the soil surface from splash erosion and the root systems will develop throughout the soil mass and help to stabilize the slope. The vegetation also provides habitat value, creates a more natural appearance, and is less visually intrusive than a concrete or masonry structure alone.
<b>Sources</b>	<ul style="list-style-type: none"> <li>● ICEM, 2017. Slope Protection Designs and Specifications, TA-8102 VIE: Promoting Climate Resilient Rural Infrastructure in Northern Vietnam, Technical Report No. 18.</li> <li>● Flexamat. Not dated. Pavement Erosion Control – Technical Information. Accessed via <a href="http://www.flexamat.com">www.flexamat.com</a>.</li> <li>● National Concrete Masonry Association. 2011. Articulating Concrete Block for Erosion Control.</li> </ul>