InnovaNet
Technology Group

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Progress Report

Dave,

We have completed our first phase of work. Dr. Louie Elliot's (University of Tennessee, Chattanooga) report is below:

PROGRESS REPORT

Objective
The primary objective of the computational work performed on the panel was to analyze the effect of slot configuration on the horizontal water flow from rainfall and to determine if the current tile/slot design allowed adequate water flow during a heavy rain. **The analysis showed that the current design does allow adequate water flow at extreme rain rates.**

Model
The computational model is a time-accurate, finite-volume, 2-D Euler fluid flow (non-compressible, non-viscous) on an unstructured cell topology. A single panel (Figure 1) is composed of 45 subcells with water transfer between cells allowed by slots in the cell faces. The simulation allows for the slot at every face to be electively on or off.

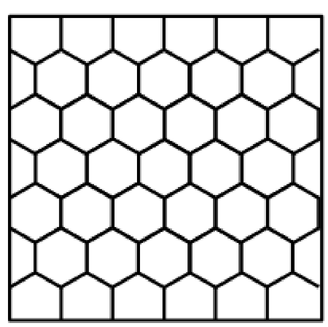

Figure 1. Panel subcell connectivity.

The velocity of water from a cell at a slot is determined by the height of water in the cell,

$$v = (2*g*h)1/2$$

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where g is the acceleration due to gravity and h is the height of water. The total volume of water transferred to a neighboring cell at a slot depends on the slot size and the time,

$$W = A*v*\Delta t$$

where A is the area of the slot, v is the water velocity, and Δt is the simulation time increment. The simulation also allows for panels to be connected in a cartesian grid to determine the net effect of multiple panels in a real world playing field environment.

The general algorithm is to compute the rainfall during each time step and add this to the existing water volume of each cell. Looping over every panel, cell, and face, the total water transfer from each cell is computed. At the end of each time iteration, the water is distributed to the proper cells. The water from cells on the boundary of the simulation accumulate into four overflow volumes, one per side.

The specified rainfall rate was 10 gal/yd/hr which is equivalent to a violent rainfall. Also, the model is implemented with the field at no pitch and the panels laid uniformly. Further simulations may include field inclination and panel rotation.

Analysis
The simulation was run with a single panel in the baseline slot configuration to determine existing flow conditions.

The parameters used in the model and their values are given Table 1,

Slot width	.625 in
Slot height	.375 in
Cell area	12.01 in^2
Rainfall rate	10.0 gal/yd/hr
Time step	1 sec
Total run time	1 hr
Number of panels (side)	1, 5, 50
Number of panels (top)	1, 5, 50
Field inclination	0 deg
Panel rotation	0 deg

Table 1: Parameters used in simulation.

Results:
The results from the simulations show that there is adequate flow with the existing slot design. In a violent rainfall for an hour, the 50x50 panel simulation showed less than an inch of standing water in the center panel. An unexpected but significant result was that there exists a preferential water flow direction away from the panel with the left and right flow being about 20% less than the top and bottom flow.

Conclusion:
The current slot design allows for adequate horizontal water flow even in extreme rainfalls.