Summary Notes for Dick Iverson Talk - OSU, 04/05/01

I. Introduction to Debris Flow / Debris Avalanches

   A. Mass Wasting Hazards - critical questions
      1. where, when, prediction, impact zone, how often (recurrence)

      2. Landslides
         a. readily observable at spatial and temporal scale
         b. not true of most geological processes / phenomena

      3. Goal of Hazards Assessment
         a. Interpret and predict behavior of mass wasting event
            (1) debris flow: characterize initiation and deposition

   B. Iverson Work
      1. Experimental approach to debris flow processes
         a. not to be confused with observational approach
         b. consideration: solid and liquid components of debris flow

II. Factors controlling Debris Flow Process
   A. Site Hydrology and topography
   B. Hydrologic / seismic / human triggers
   C. slope failure threshold point
   D. slide to flow transformation processes
      1. flow = very mobile with large runout "footprint"
      2. slides - more aereally restricted
   E. Size and shape of runout zone
      1. controlled by physics and dynamics of flow

** Factors A and E are directly observable at spatial and temporal time scales, factors B-D are unknowns

III. Initiation Factors
   A. intensity-duration thresholds of rainfall events
   B. soil factors
      1. fluid-solid interaction
         a. debris flows = mixtures of solids and fluids
         b. fluid content in 10-30% range max
      2. porosity
      3. permeability
      4. pore pressure response

IV. Math Models / Physics
   A. Newton's Law of Motion
      1. F = ma
         a. In debris flow, F changes with time
         b. pore pressure driven (solid-fluid interaction)

c. need to know soil depth, hydraulic conductivity, rainfall intensity

V. H.J. Andrews Flume Experiments on Debris Flow

A. Conservation of Mass and Momentum

B. Experimental Design

1. 31 degree flume slope

2. measurements

a. tilt meter for vertical deformation profile of flow

b. surface displacement and velocity of flow

c. pore fluid pressure

(1) negative pore pressure = undersaturated (partially filled pores; capillary force, < atmospheric pressure)

(2) positive pore pressure = fully saturated pore spaces (> atmospheric pressure)

d. variables

(1) soil and sediment mixtures

(2) water content

(3) soil density and porosity

(a) compaction control

(b) soil density controls porosity content

(4) rate of water infiltration (simulated "rainfall intensity")

3. sediment-water mixture

a. ~10 cubic meters of sediment + 3 cubic meters of water

(1) sand-gravel mix + 1-15% silt-clay

(2) clay = cohesive material

b. Debris flow velocities on order of ~ 10 m/sec

C. Experimental Results and Observations

1. to initiate failure

a. add water to sediment to saturate

(1) pore pressure is initially low (negative)

(2) pore pressure increases to threshold of failure

(3) during transport, pore pressure pulsates by increasing and decreasing

(a) pulsating pore pressure drives debris flow mechanics

2. Model

a. As soil dilates (increases in volume), pore pressure decreases

b. Dense soil

(1) characterized by episodic slump

(2) basal shear of soil mass, soil mass dilation, pore pressure decrease

c. Loose Soil

(1) tendency for rapid failure

(2) As shear occurs, pore pressure increases, soil dilates and results in liquefaction and flow

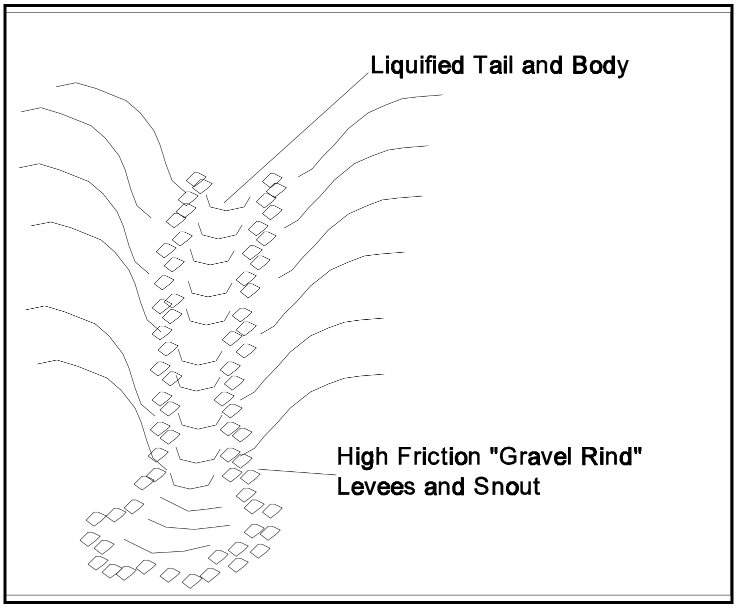
3. Superelevation of debris flow around curves

a. "run up" - height that debris flow rises as it banks curve

(1) centrifugal force causes mass of debris flow to rise up the outside of bends

b. "superelevation" = angle of slope of debris flow as measured from outside curve to inside curve

VI. Conceptual Model of Flume Results



- debris flow = mixture of solids and viscous liquid
- pore fluid pressure modulates intergranular friction

A. Numerical Modelling of Debris Flow Processes

1. model uses independently measured variables to predict flow behavior
   a. model results / predictions
      (1) flow depth / deposit thickness
      (2) runout zone footprint / shape
      (3) flow velocity