Grad Workshop Problems 2016

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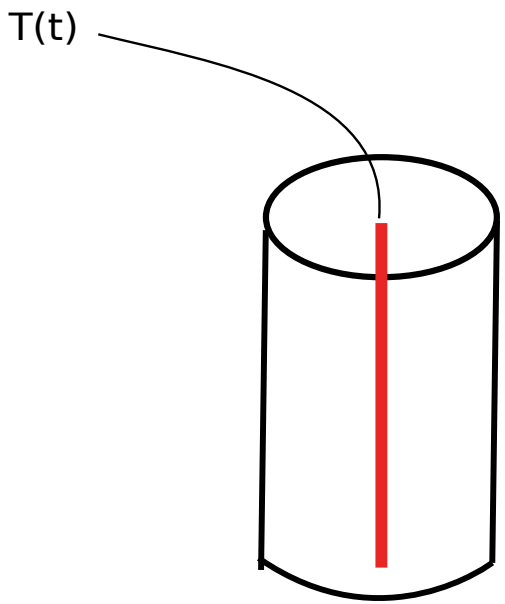
Design of a State Change Measurement Instrument

Design an instrument for determining the state change characteristics of a range of organic substances (Latent heat, Solidification Temperature).
The Apparatus consists of a metal cylinder (length about 1m, radius about 20 cm) with a temperature probe inserted down its axis.

The Procedure

- The cylinder is filled with the material and the temperature raised above the melting point of the substance.
- The cylinder is then placed in a cold bath so that a solidification front propagates through the substance from the cylindrical wall to its axis.
- The temperature probe measures the temperature variation in time ‘at’ the axis of the cylinder.



Mathematics Required

The conductivities, specific heats of the material are known.
Knowing $T(t)$ find L, T_{sol}.

Mathemaics

- Heat equation (separation of variables...). State change.
- Approximation procedures (analytic, numerical).

Followup:

Often there is no 'single state change' occurring, with a 'continuum of solidification states' with associated internal heat content. Can one extend the model results?

A Safety Barrier for Dumptrucks

Enormous dump trucks (5 m high) are used to move soil/rocks from vast open cut mines (for example the gold mine Superpit in Kalgoorlie WA).
Typical loads 500 tons, Typical Speeds 15-20 km/hr.

The Superpit

The trucks remove much waste and little valuable material from the mine.

Safety Barrier Design: Safescape

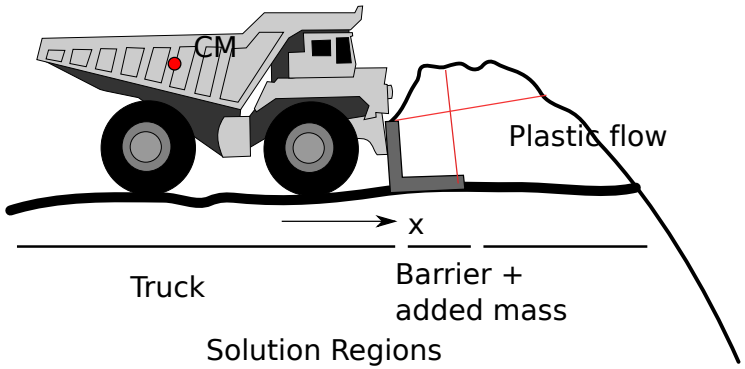


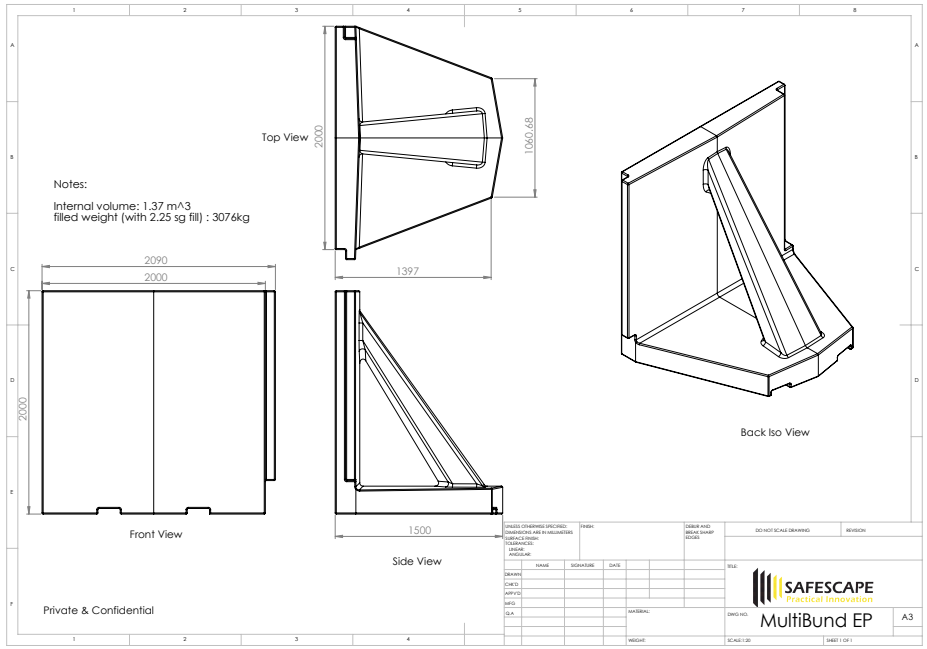
Figure : A worst Scenario

Drivers drive long hours along narrow roads. Should they drop off the edge; disaster!

Can a concrete filled barrier prevent such an accident?

Bund Design: Safescape

Presently barriers about 2 m high and 2-3m wide. Two or three are joined together. Behind the barrier soil is piled up.



What barrier height, width, weight? What depth soil behind?

Mathematics

- Mechanics
- Plastic Flow (characteristics...)