Dumptruck Problem

Supervision by Prof.Neville Fowekes

Arzag Nour (arzag@aims.ac.za)

January 9, 2016

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Problem Statement:

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 trucks remove much waste and small amount of valuable material from the mine. Drivers drive long hours along narrow roads. Should they drop off the edge; disaster!

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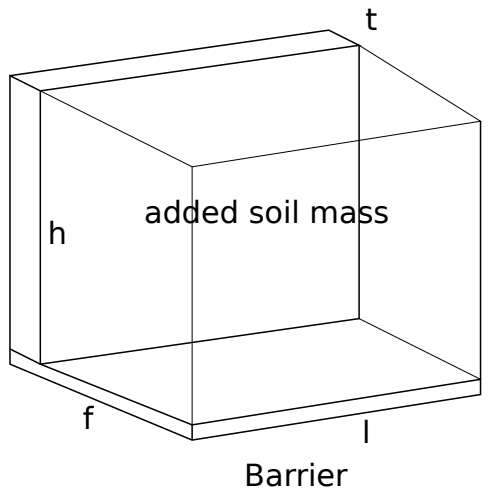
Aim and model outlines

Our aim is: **Design a barrier for safety.**

Think! Which barrier characteristics are required To achieve safety?

The model outlines:

- The factors which will affect on the interaction between the dump truck and the barrier.
- The required structure for the soil behind the barrier.



System equation and tasks I

Dump Truck Equation:

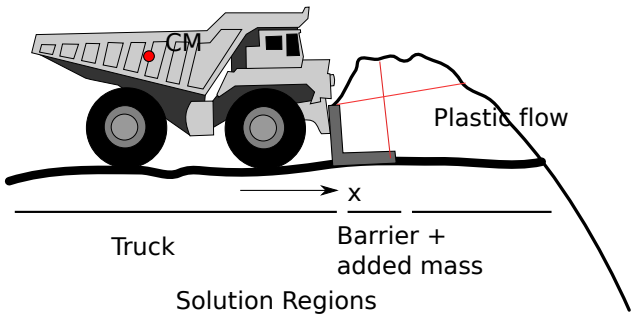
Main mathematical task: Determine the stopping distance x_s (barrier and pile geometry, initial truck speed, loading).

$$M\ddot{x} = -F_{tot}$$

By integration with respect to x we will end with.

$$x_s = \frac{M{U_o}^2}{2F_{tot}}$$

where M is the mass of the truck and U_o is the initial velocity.



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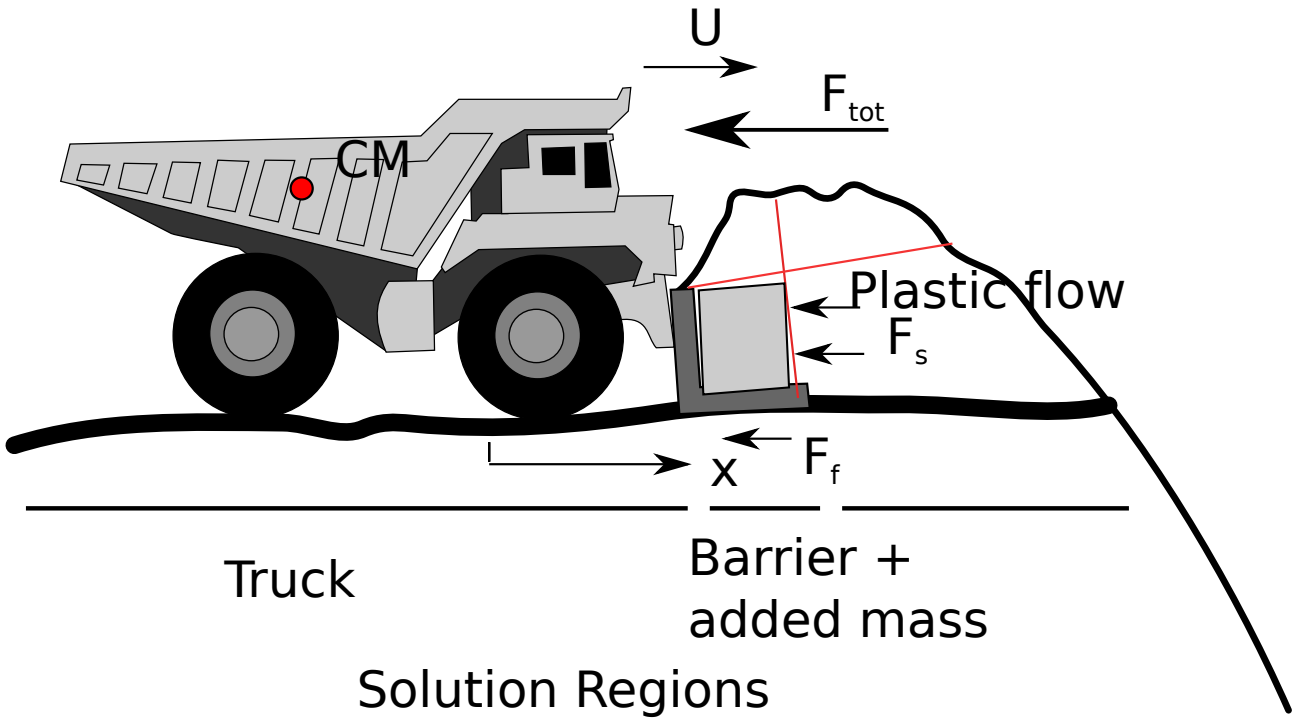
System equation and tasks II

Barrier and pile equation:



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Task : Analysis F_{tot}

Fractional force:

- The force outing from the friction between the mass of the barrier and the add soil mass with the ground.
- $F_f = \mu(m_b + m_a)g$,μ is the frictional coefficient.

Soil Force

- The normal force acting on the barrier.
- $F_s = 2hl(S_{max} + \sigma_1)$ with $\sigma_1 = \rho_s gh/2$.
- S_{max} is the maximum shear stress that the soil can take before yielding.
- h is the soil height and σ_1 is the gravitational pressure per unit area on the face of barrier.
- Given by the plasticity flow theory.

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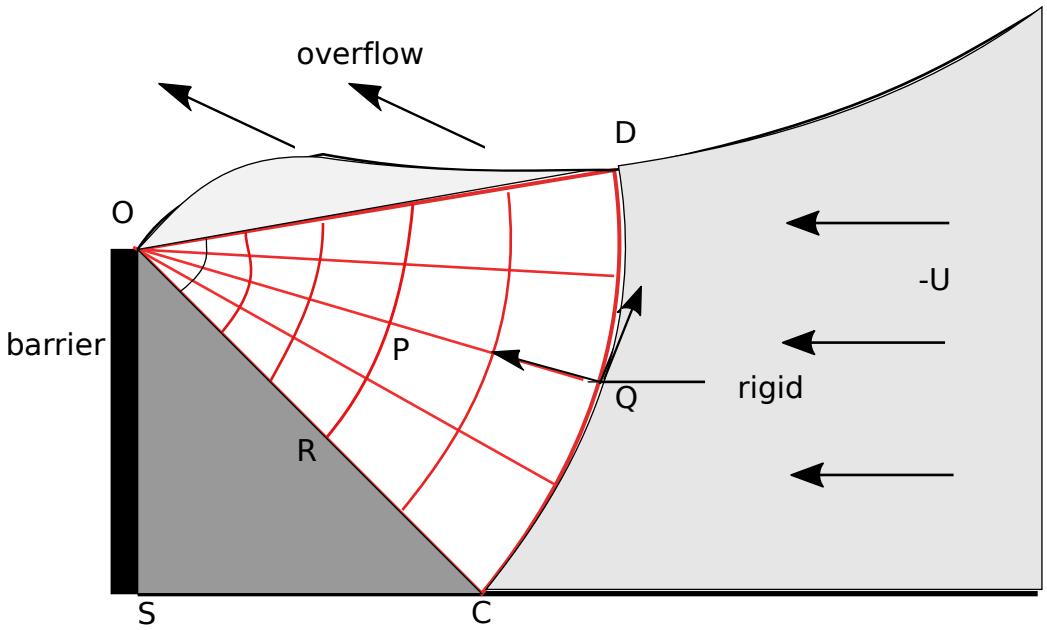
(arzag@aims.ac.za)

Plastic Flow theory

Studying the plastic flow of the soil



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Typical result

H=2 m and $\rho_s = 1600 Kg/m^3$

Full Truck

U_o Km/hr	x_s m
15	5.6
20	9

Empty Truck

U_o Km/hr	x_s m
20	3.98
15	0.75

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Conclusion

we know that: $x_s = \frac{MU_o^2}{2F_{tot}}$
From this relation we can say :

- x_s is directly proportional to the mass of the truck and the square of the initial velocity.
- x_s is directly proportional to $\frac{1}{F_{tot}}$ and the important factor really affect on this relation the density of soil and shear maximum stress.