

Exam Dredging processes Wb3413

General

1. Derive the equations describing the Mohr circle and make a drawing of the Mohr circle, containing the shear and the normal stresses, the failure envelope and the angle of internal friction.
2. Derive the settling velocity of sphere's and explain how in practice the settling velocity of grains has to be determined (consider laminar and turbulent settling and a transition zone).

The Cutting of Sand

Consider sand with the following properties:

$$\begin{aligned}\phi &= 40^\circ \\ \delta &= 30^\circ \\ k_i &= 0.00002 \text{ m/s} \\ k_{\max} &= 0.0002 \text{ m/s} \\ n_i &= 42\% \\ n_{\max} &= 50\%\end{aligned}$$

Blade properties:

$$\begin{aligned}\alpha &= 45^\circ \\ \beta &= 30^\circ \\ h_b &= 0.1 \text{ m} \\ h_i &= 0.1 \text{ m} \\ b &= 0.5 \text{ m}\end{aligned}$$

1. Make a graph of the Mohr circle of the sand.
2. Explain the phenomenon of dilatancy.
3. What is the difference between passive and active soil failure.
4. Make a graph of the horizontal cutting force as a function of the cutting velocity up to 5 m/s, for water depths of 0, 10 and 20 m.
5. Determine the specific energy at a cutting speed of 1 m/sec for the 3 waterdepths.

The Cutting of Clay

Consider clay with the following properties:

$$\begin{aligned}c &= 50 \text{ kPa (cohesion)} \\ a &= 25 \text{ kPa (adhesion)} \\ t &= 10 \text{ kPa (tensile strength)}\end{aligned}$$

1. Determine the cutting forces on the blade as described with sand cutting for the flow type of cutting process (velocity effects can be neglected).
2. Determine the specific energy.

Hopper Sedimentation

Consider a hopper with the following dimensions:

Length	50 m
Width	10 m
Height	6 m
Design density	1.4 ton/m ³
Flow	5 m ³ /sec
Density	1.3 ton/m ³

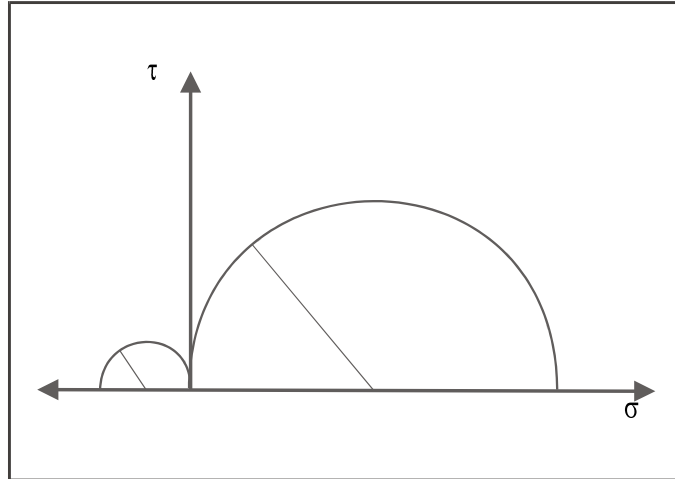
1. Explain the 8 phases of the loading process.
2. Determine the Hopper Load Parameter and explain the meaning of this parameter.
3. Suppose the weight of the contents of the hopper is 4000 tons, determine the effective load and the tons dry solid.
Has the overflow level been reached?
4. Determine the settling efficiency for a 100 μm grain.

Breaching Process

1. By moving a suction tube in dense sand with a constant velocity in a horizontal direction, it creates a suction pit with variable slopes. The slope angle has a maximum in front of the suction tube and decreases towards the sides of the pit to an equilibrium value α .
 - On which variables depends the angle β in front of the suction tube?
 - What is the physical reason that the angle β is larger than α ?
2. The theoretical maximum production of a 10 m deep suction pit with sand of 100 μm is about 600 m³/hr and when dredging sand of 200 μm about 2400 m³/hr. The dredger is capable to dredge a production of 2500 m³/hr.
 - To which depth should the suction pit with 100 μm to be increased to reach the same production as for 200 μm sand?

The Cutting of Rock

1. In the below given figure two circle are drawn from different tests.
 - What kind of tests belongs to those circles?



- Draw in this figure the point of failure when the theory of Evans is valid.
2. Fractures in a rock can have a great influence on the production of a cutter dredger. Please explain why?
 3. In the below given figure the failure of brittle material is given according to Evans. When $\alpha=30^\circ$ and $d=0.05$ m and the uni-axial tensile strength is 4 MPa, calculate the total tensile force T

