

Intro Cutter Suction Dredge

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Contents

- Intro
- General lay-out
- Working Method
- Cutter head
- Intro Cutting Theory (Sand and Rock)
- Mixing in cutter – spillage
- Operational Limits



Cutter Suction Dredgers

Small < 250 kW



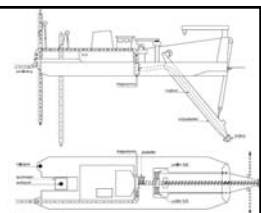
Large > 2500 kW

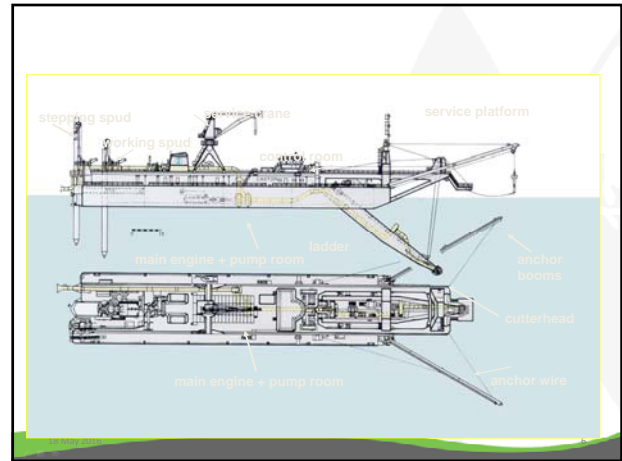
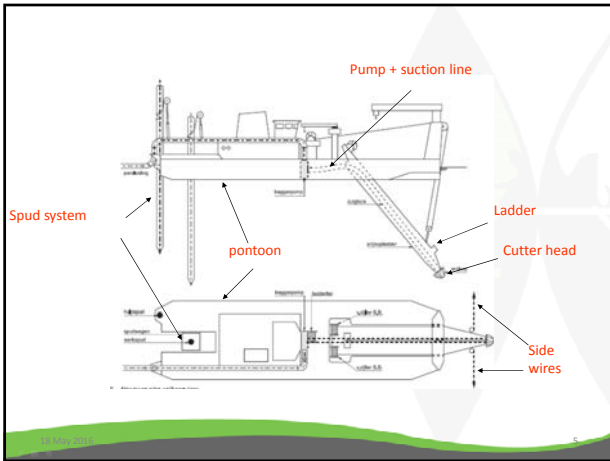


Medium, 1500 kW

Components

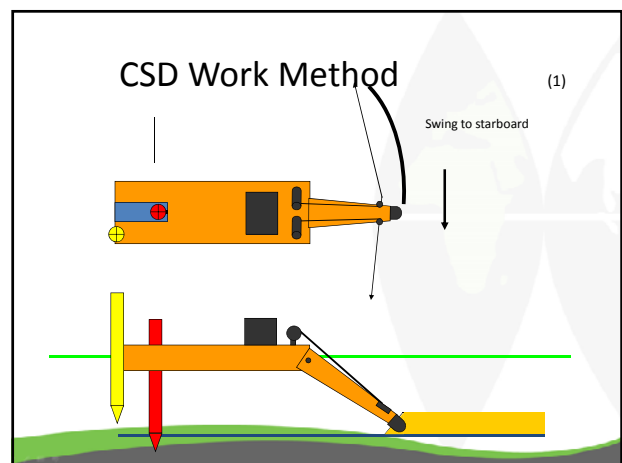
- Pontoon
- Ladder
 - Cutter head + drive system
 - Suction line
 - Support system + winch
- Spuds
- Pumps + discharge system
- Side wires + winches

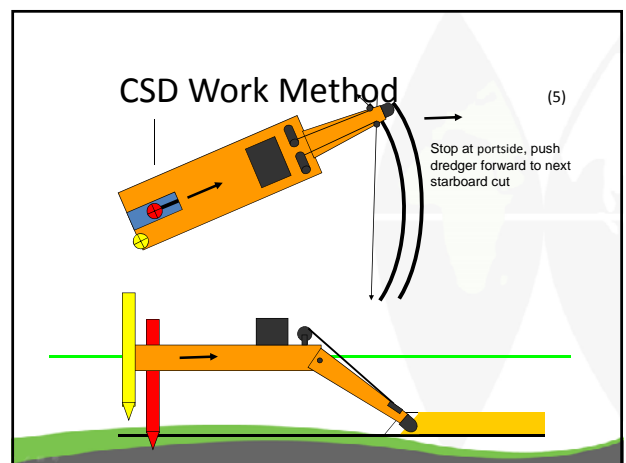
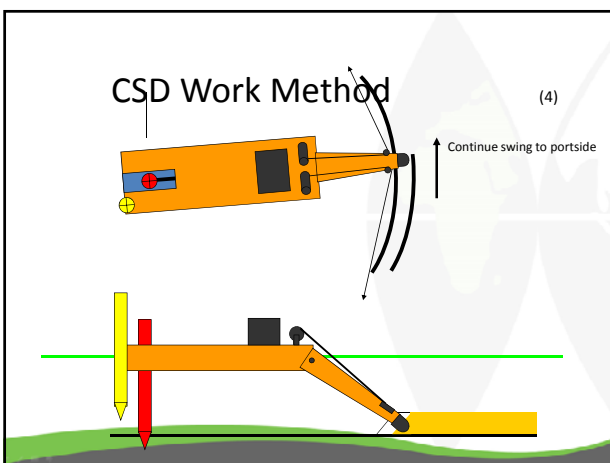
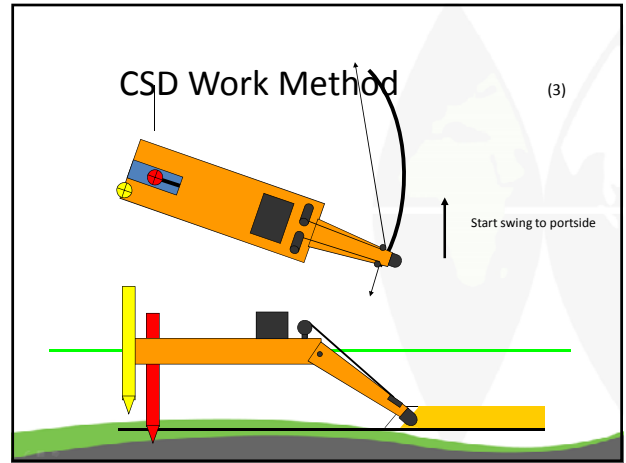
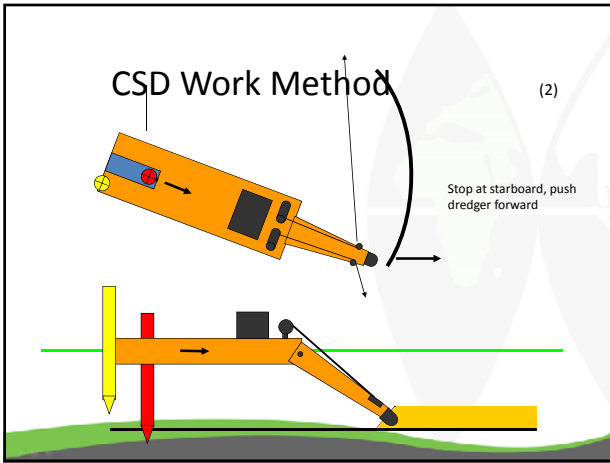


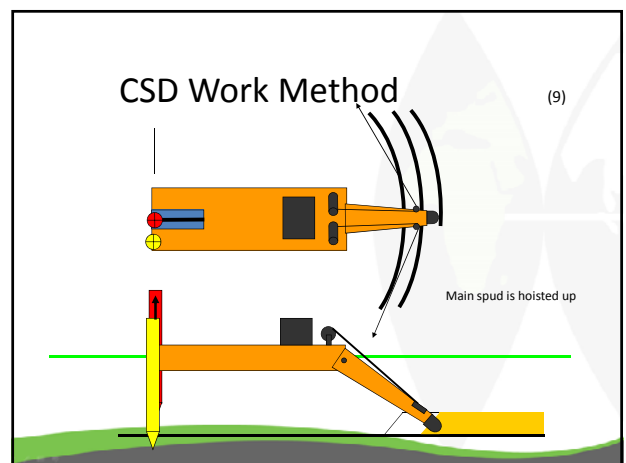
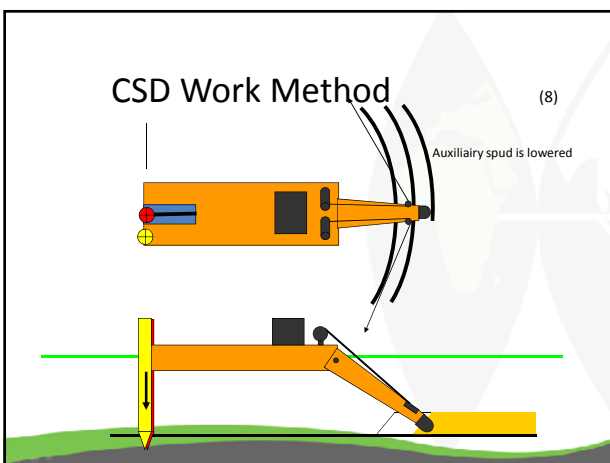
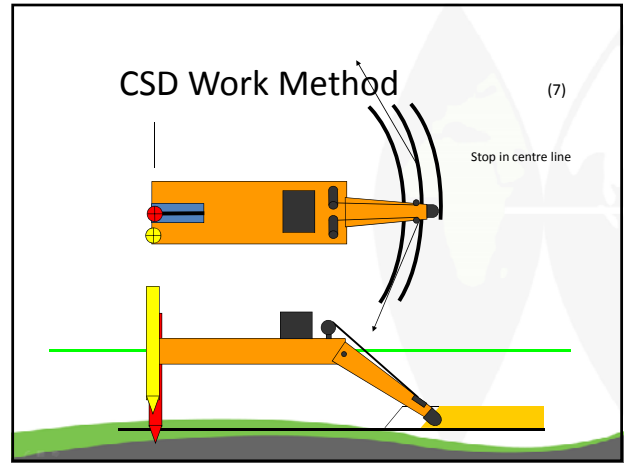
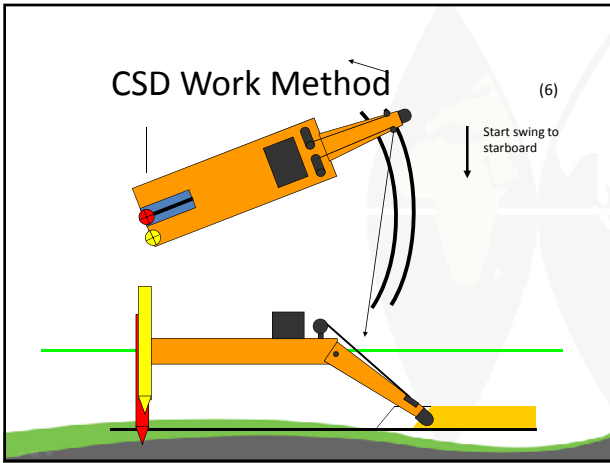


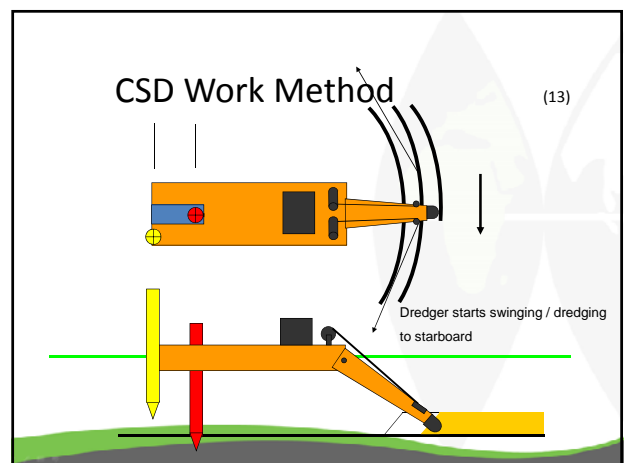
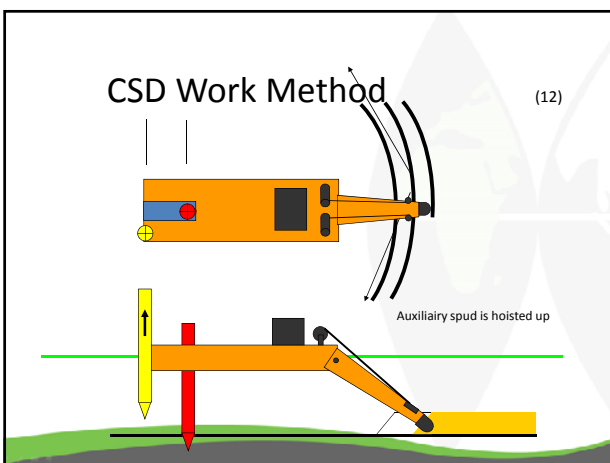
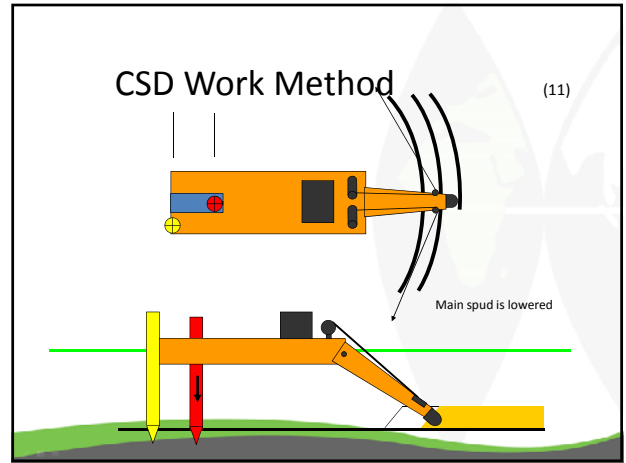
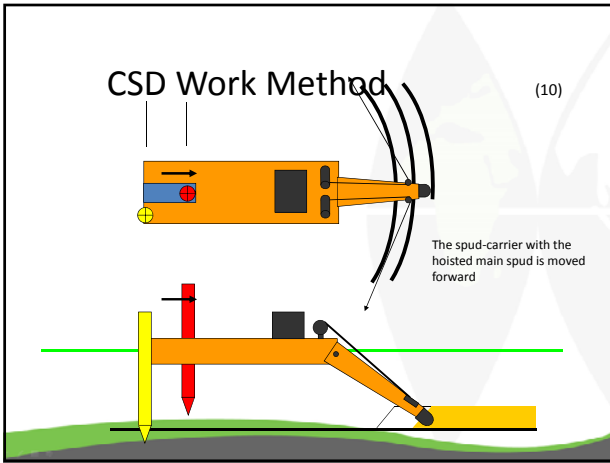
Working principle

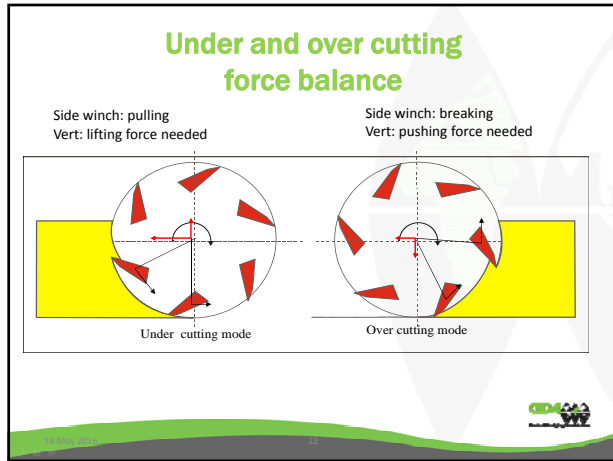
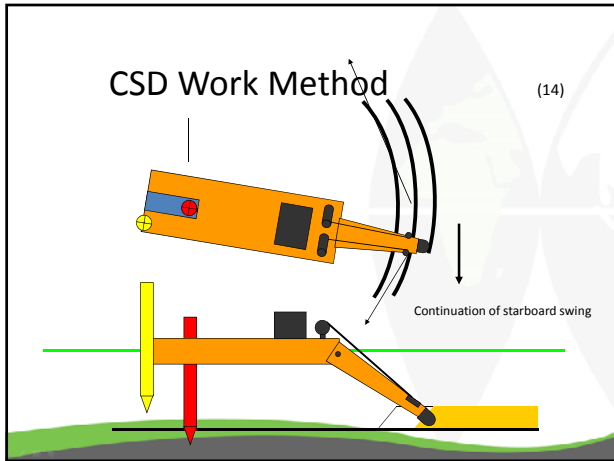
- Cutter disintegrates or dislodges the material mechanically by rotating cutter head
- Swinging around working spud
- Progress by successive steps
- Material sucked up and transported through pipeline by use of centrifugal dredge pumps







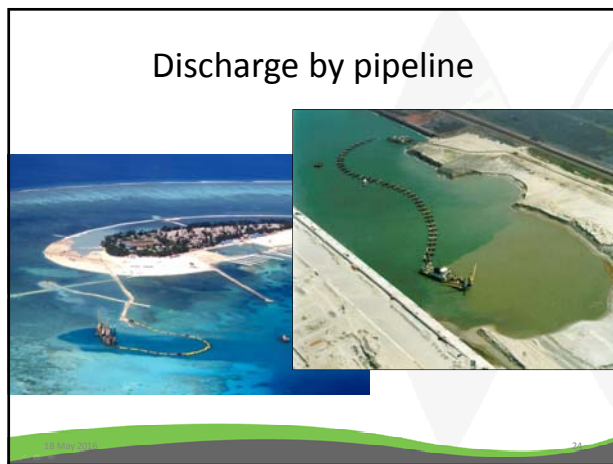




Discharge Methods

- Pipeline
- Barge loading

A small logo is located in the bottom right corner of the slide.



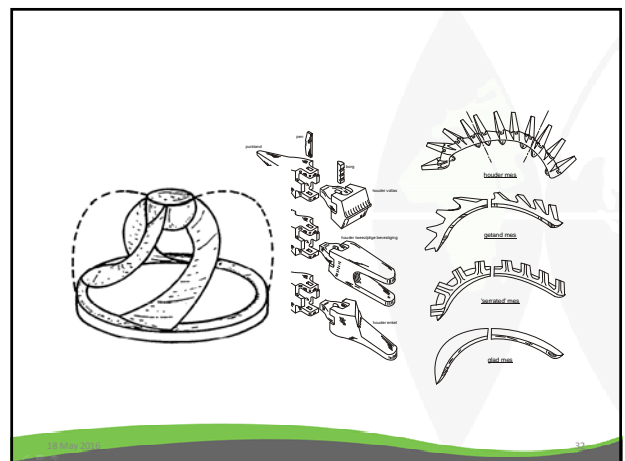
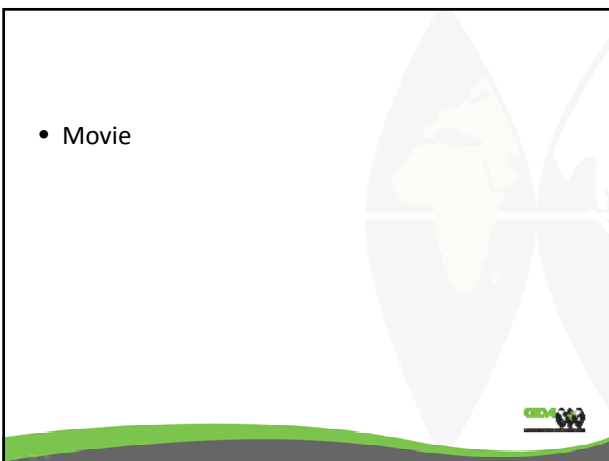
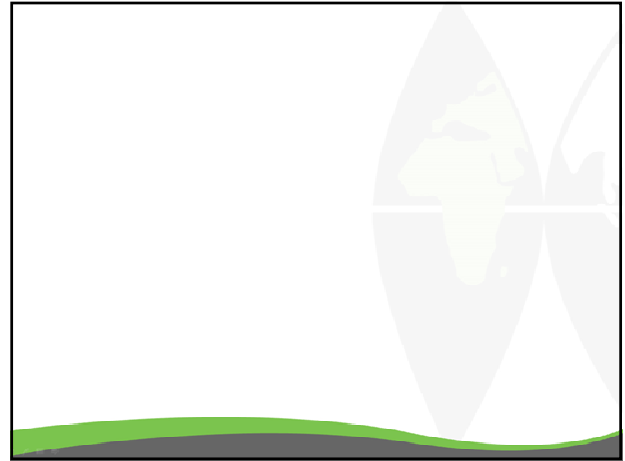
Barge loading

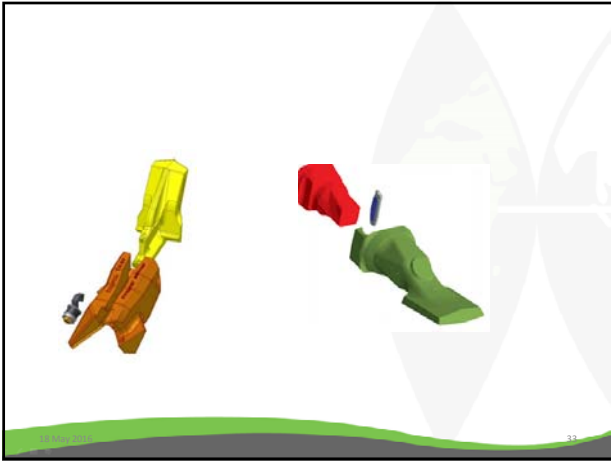


Cutter Head

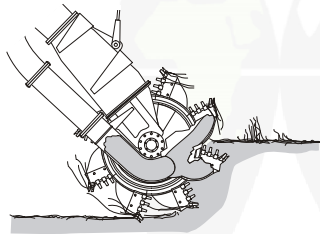
- General
- Teeth systems
- Cutting process
- Mixing process







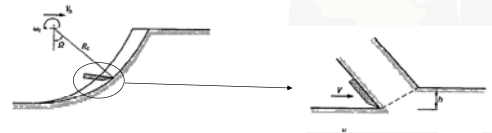
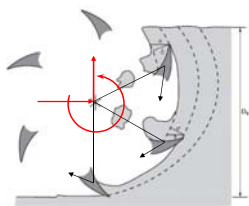
Bucket wheels

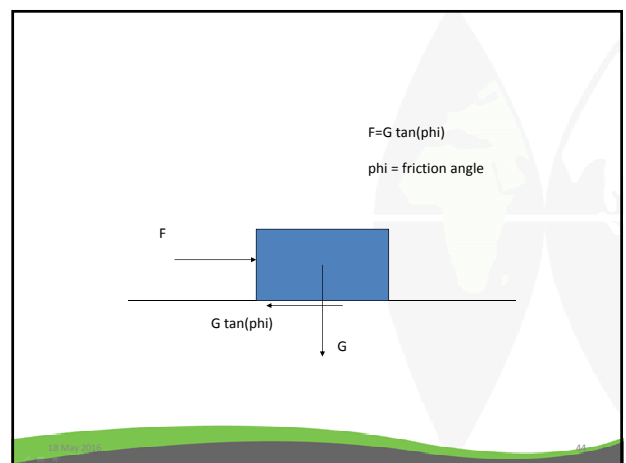
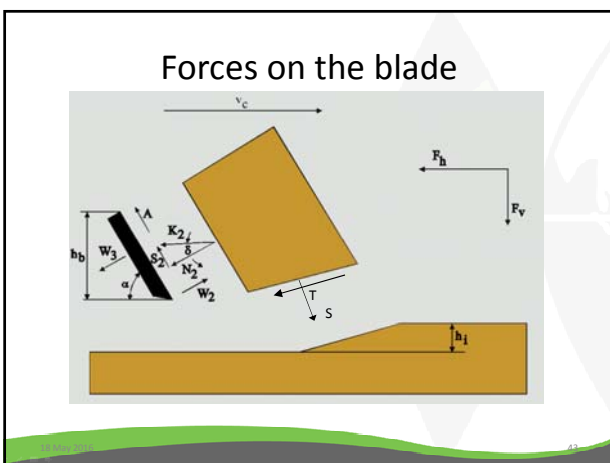
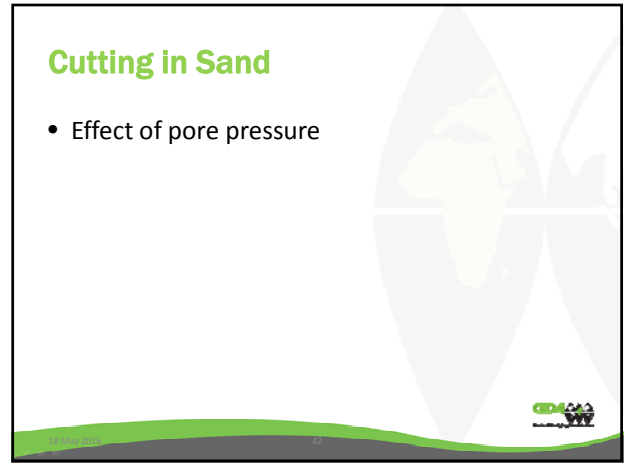
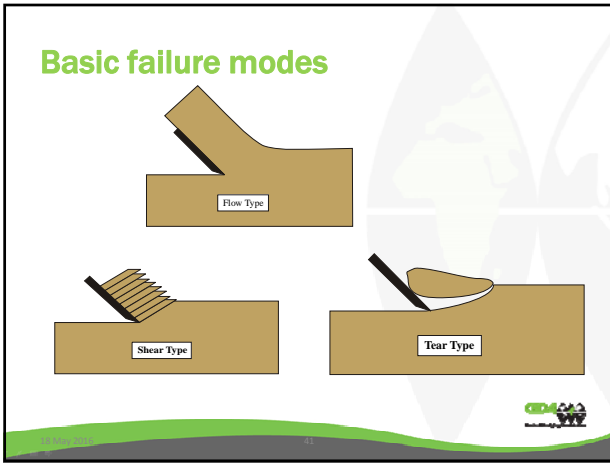


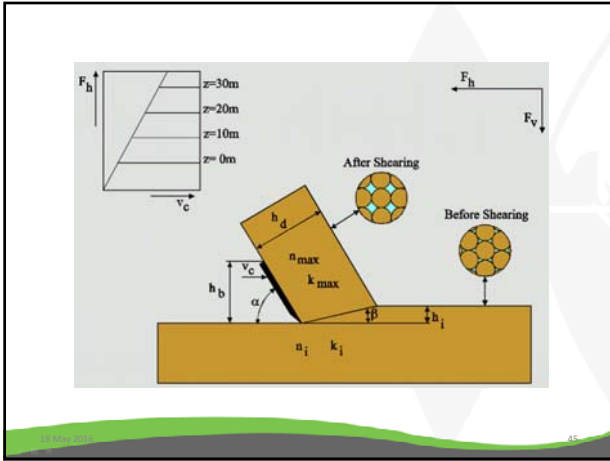
Ellicott wheel



Cutting Theory

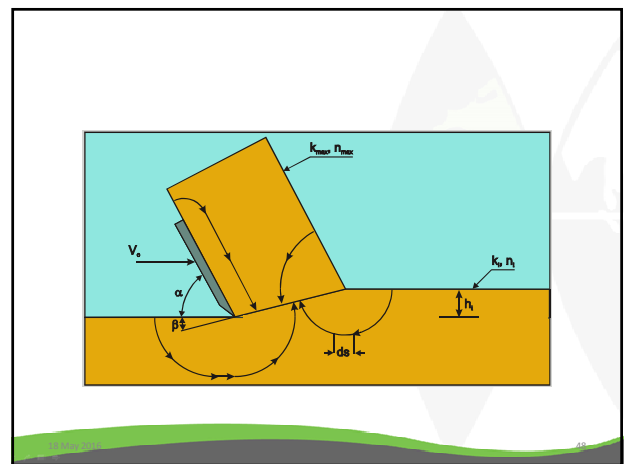
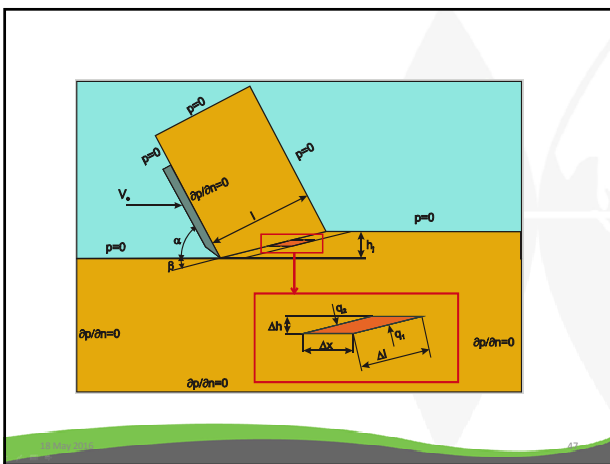


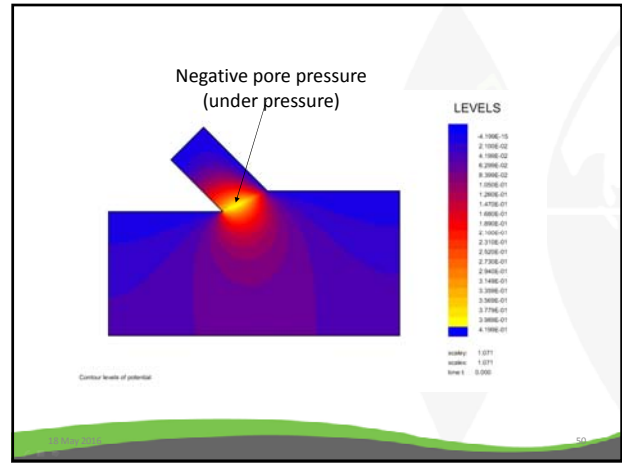
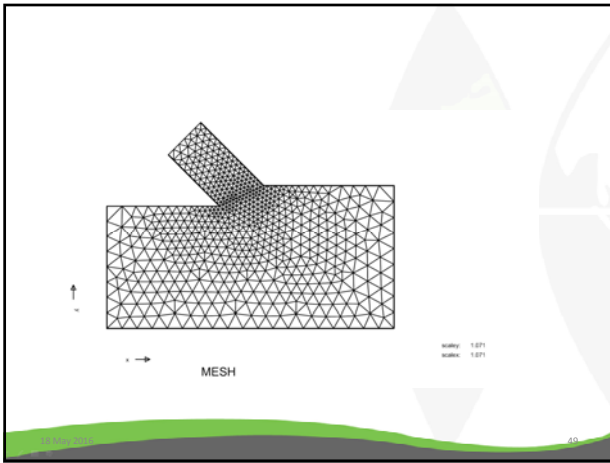




Dilatancy

- Dilatancy explained





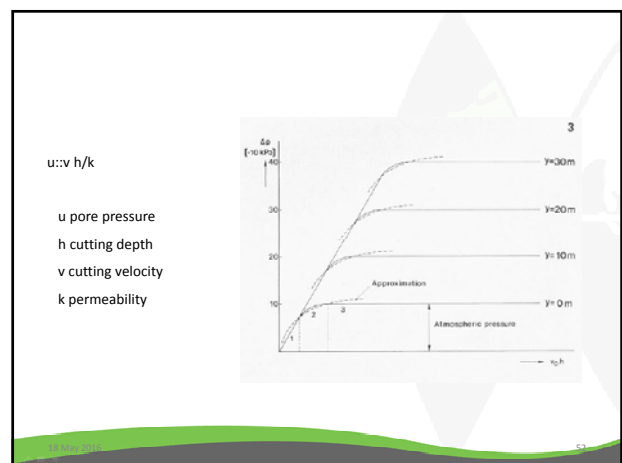
Forces on layer – effect of dilatancy

$T = S' \tan(\phi)$ Coulomb

$S' = S - u$

S' : effective stress
 S : Total Stress
 u : Pore water pressure

$S \approx 0$: $S' = -u$
 Pore water pressure is negative
 Increase in effective stress
 Increase in Shear stress



Cutting Sand:

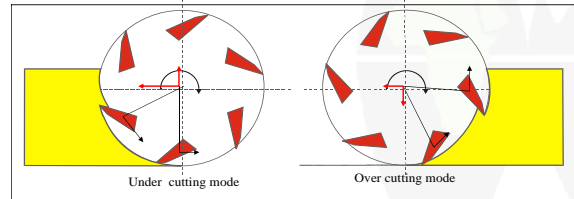
- Larger Cutting forces with
 - Lower permeability (finer sand)
 - Increase cutting depth & velocity
 - Increase water depth



Under and over cutting force balance

Side winch: pulling
Vert: lifting force needed

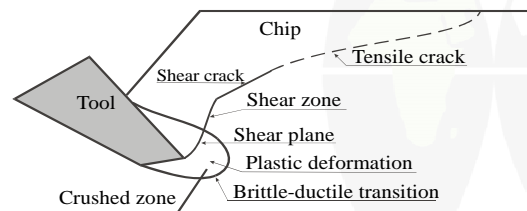
Side winch: breaking
Vert: pushing force needed



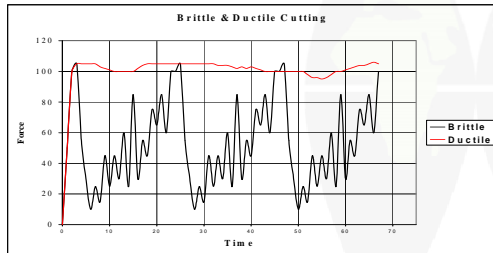
Rock Cutting

50

Failure modes during Cutting



Forces during cutting

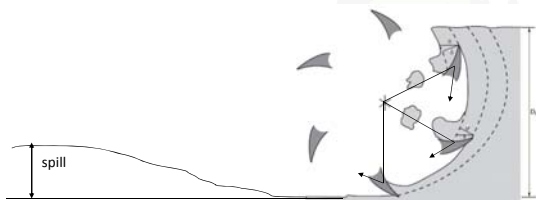


Rock cutting

- Large cutting forces
 - Strength Cutter and teeth
 - Teeth placement important
 - Tooth wear

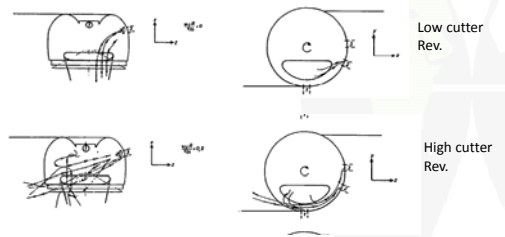


Spillage



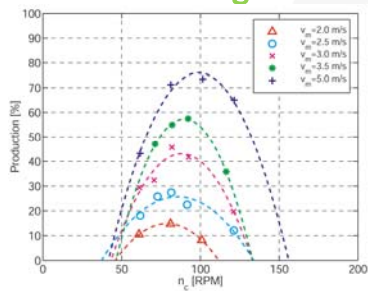
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Spillage



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Cutter head production process In rock or gravel



Cutter head productions c.q. Spillage

•The rotational speed of the cutter head causes spillage.

–Cutter acts as a pump

•The productivity c.q. spillage depends on the ratio:

•For sand the productivity is: $P_r \approx 2.5 \frac{Q_{pump}}{\omega R_{cutter}^3}$

•For rock the productivity is much lower

Influence of waves on operation

- CSD is a floating object
- Response due to wave loading as with other floating structures, but
 - Typical geometry of pontoon with ladder
 - Interaction with soil
 - Spud – Spud carriage system
 - Cutter head
- Numerical prediction still not satisfactory

Wave influence

- CSD not only decisive
 - Aux. Equipment
 - Coupling, de-coupling of floating pipeline

Application of CSD

- Nearly all kinds of soils (sand, clay, rock <30 MPa)
- Sensitive to wave conditions
- Stationary dredger (vulnerable for shipping)
- Some are self-propelled for mobilisation
- Max. dredging depth 30 m



Limiting Factors

- Excavation
 - Soil characteristics
 - Available power on cutter
 - Side winches (max. power and velocity)
 - Thickness and width of the layer to be dredged
- Dredging depth (ladder angle, spuds, vacuum limit)
- Pumping distance (pump- and pump drive characteristics)
- Shipping



Next Webinar : Intro Trailing Suction Hopper Dredge

- September 14 2016
- 14:00 – 15:00 CEST

