[PRINT]

CIE4305 Coastal Dynamics I (2017-2018), ZHI LI, 3/11/18 at 9:30:18 AM CET

Question 1: *Score 0/2*

Inman and Bagnold (1963) derived a bulk longshore transport formula by applying the energetics concept to the littoral zone.

They expressed the bulk immersed weight longshore transport rate as:

$$I = \frac{e\left(Ec_g\right)_b \cos\left(\varphi_b\right) V}{\mu \hat{u}_b}$$

in which *e* is an efficiency factor, φ_b is the wave angle of incidence at the breaker line, $\mu = \tan\varphi$ is the internal angle of repose of the sediment, $\hat{u}_b$ is the orbital velocity amplitude just before breaking and *V* is a representative longshore current velocity.

Further, in the term $(Ec_g)_b$, *E* is the wave energy, c_g the group velocity and the subscript *b* denotes that the term is evaluated at the breaker line.

Which part in this equation represents the amount of wave power (per unit shoreline length) that is used in the surf zone for mobilising sediment? Select the right answer:

Your response	Correct response
$\frac{e\cos\left(\varphi_b\right) V}{\mu \hat{u}_b}$	

Grade: 0/1.0

Total grade: 0.0×1/1 = 0%

Feedback:

Per unit wave crest width, the total wave power that is available for dissipation in the surf zone is $(Ec_g)_b$. Not all of this is used for mobilising sediment, hence the efficiency factor e. Further, the question was about the wave power per unit shoreline; this is where the term with the wave angle comes in.

Theory: section 5.2.1 (Energy balance), section 6.7 (Energetics approach) and Intermezzo 8-1 (Bulk longshore transport based on the energetics approach).

Question 2: *Score 0/3*

A conservation statement for the sediment can be written as:

$$\underbrace{\frac{\partial c}{\partial t}}_{A} + \underbrace{u\frac{\partial c}{\partial x}}_{B} + \underbrace{v\frac{\partial c}{\partial y}}_{C} + \underbrace{w\frac{\partial c}{\partial z}}_{D} - \underbrace{w_s\frac{\partial c}{\partial z}}_{E} = \underbrace{\frac{\partial}{\partial z}\nu_{t,s}\frac{\partial c}{\partial z}}_{F} + \ldots$$

The velocity *(u, v, w)* in *(x, y, z)*-direction and the concentration *c* are signals consisting of a mean and an oscillatory and a turbulent part.

Further, w_s is the sediment fall and $\nu_{t,s}$ is the turbulent diffusivity of sediment mass.

Now consider the central section of a Large Oscillating Water Tunnel (LOWT) in which experiments are performed with an oscillating velocity signal under sheet flow conditions. The *z*-direction is the vertical direction, the *x*-direction is along the tunnel, the *y*-direction perpendicular to it.

Select the term(s) that is (are) zero for this situation:

Your response	Correct response
Choice 6: F	

Grade: 0/1.0

Total grade: 0.0×1/1 = 0%

Feedback:

In the LOWT, the piston generates a purely horizontal, oscillatory flow without phase differences along the tunnel axis. Thus, vertical orbital velocities are zero and horizontal gradients of the flow are absent.

(On a separate note: what does this mean for the wave-induced streaming? Is it possible to simulate this in the LOWT?).

Rippled bed could locally introduce spatial gradients in the flow and sediment concentration. For sheet flow conditions however, these gradients are absent.

With this knowledge, you should be able to determine which terms can be neglected in the wave tunnel.

Theory: section 6.6.2 (Sediment continuity) and intermezzo 6-6 (Intra-wave sediment concentration)

Question 3: *Score 1/2*

It may happen that at certain heights above the bed the net flux of sediment transported by the oscillatory motion is against the wave propagation direction.

Which factors could contribute to such a situation:

Your response	Correct response

Choice 1: a flat sediment bed: TRUE Choice 3: fine sediment: TRUE Choice 6: long wave periods: FALSE Choice 8: low turbulence levels: FALSE	

Grade: 0.5/1.0

Total grade: 0.5×1/1 = 50%

Feedback:

It is possible that the sediment is transported against the wave propagation direction if the sediment is not following the hydrodynamic changes directly (there could be a delay). A delay may occur for finer sediment and for higher turbulence levels that bring sediment higher up in the vertical. Whether transport against the wave propagation direction occurs is determined by the response time of the sediment **relative** to the wave period; hence, a shorter the wave period would increase the possibility of transport against the wave propagation direction. Finally, bed ripples influence the timing of the sediment suspension; bed ripples can lead to suspension events at flow reversal and could therefore also cause transport against the wave propagation direction.

Theory: section 6.6. (Diffusion appoach for) and 6.8.1 (Memory effects)

Question 4: *Score 2/2*

The Rouse number is defined as $w_s/(\kappa\, u_*)$, in which w_s is the sediment fall velocity, κ=0.4 is the von Karman constant and u_* is the shear velocity.

Note that the shear velocity is related to the bed shear stress through $\tau_b = u_*|u_*|$.

A quasi-steady sediment transport model is more likely to be valid for the situation:

Your response	Correct response
Choice 2: of a small Rouse number (say smaller than 2.5): FALSE Choice 3: that bed load transport is the dominant transport mode: TRUE	

Grade: 1/1.0

Total grade: 1.0×1/1 = 100%

Feedback:

For a quasi-steady sediment transport model, the sediment is assumed to respond instantaneously to velocity or shear stress variations. This is applicable for bed-load transport and not for suspended load transport. The larger the fall velocity, the more sediment will be transported in bed load mode and vice versa.

Theory: sections 6.4.3 (Practical modelling of sediment transport) and 6.6.3 (Time-averaged concentration distribution)

Question 5: *Score 2/2*

Consider a structurally eroding coast.

During a certain field experiment, the bed levels in the active zone of a certain cross-section are regularly measured.

A student says that it is possible to determine the cross-shore sediment transport rates from measured bed level changes.

Is he right?

Your response	Correct response
No	

Grade: 1/1.0

Total grade: 1.0×1/1 = 100%

Feedback:

The sediment transport rates are related to the bed level changes, through the mass balance of sediment:

$$(1-p)\,\frac{\partial z_b}{\partial t}+\frac{\partial S_x}{\partial x}+\frac{\partial S_y}{\partial y}=0$$

So if you know the bed changes, there are still two unknown terms. Only if one of these two remaining terms is known (for instance zero), the other can be solved. For a structurally eroding coast, the alongshore transport gradients cannot be neglected. However, if you know that the alongshore transport gradients are zero, the cross-shore transport gradients can be determined. If you also know the boundary conditions at both sides of the profile, the cross-shore transport rates can be solved.

Theory: section 6.4.1 (Definitions)

Question 6: *Score 2/2*

A coastal engineer needs to estimate yearly-averaged wave-induced alongshore sediment transport rates for a straight, uninterrupted, dissipative coast.

Along this coast a shore-normal breakwater has been built extending well beyond the surf zone.

The coastal engineer is asked to choose between three tools to determine these transport rates.

Which of the three would you advise him to use?

Correct

Your Answer: aerial photographs - taken in 5 subsequent years - of the accretion updrift of the breakwater

Feedback: The breakwater extends well beyond the surf zone, so the breakwater will block all alongshore sediment transport. As all upstream sediment transport is trapped by the breakwater, the yearly deposited volume upstream of the breakwater is a very good indication for the yearly-averaged sediment transport rates. Therefore, yearly taken aerial photographs could give a good indication for these transport rates.

The depth of the scour hole at the tip of the breakwater is not a good indication of the total transported volume throughout the year. Further, five measurement points of sediment concentrations and current are not enough to make an accurate estimation of the verticallty integrated transport at that location, let alone of the alongshore sediment transport rates integrated over the entire littoral zone.

Theory: section 1.5.2 (Coastal morphodynamics) and lecture slides of chapter 6

Question 7: *Score 0/2*

Two students have calculated sediment transport rates.

They both performed the calculation correctly.

However, student 1 has expressed the transport rates in immersed mass (in kg/m/s) and student 2 in volume of solid material (in m^3/m/s).

Student 2 found an answer (S_2) that is related to the answer of Student 1 (S_1) through:

S_2=

Your response	Correct response
1/(2650-1000)/0.6	

Grade: 0/1.0

* S_1

Tip: You can write the mathematical expression in the text box (e.g. 1/5*3 is equivalent to 0.6 and both answers are accepted).

Attention: Use the point as a decimal separator!

Constants:

Water density: ρ=1000 kg/m^3

Sediment density: ρ_s=2650 kg/m^3

Porosity: p=0.4

Gravitational acceleration: g=9.81 m/s^2

Total grade: 0.0×1/1 = 0%

Feedback:

To find the answer, you should look carefully to the units of the different expressions. Some considerations you should take into account:

- The immersed weight is less than the weight of dry sand (Archimedes' principle);
- The weight is not the same as the mass;
- The volume of solid material is less than volume of deposited material (here the porosity comes in).

Theory: sections 6.2.2 (Grain size, density and bulk properties) and 6.4.1 (Definitions)