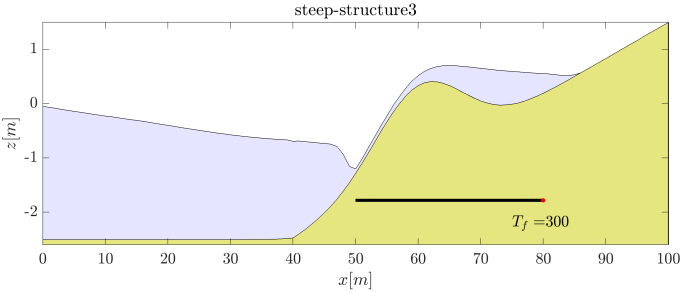
Candidate CHARTS Model Update

Brad Johnson
Liz Holzenthal
Rusty Permenter
Kevin Hodgens

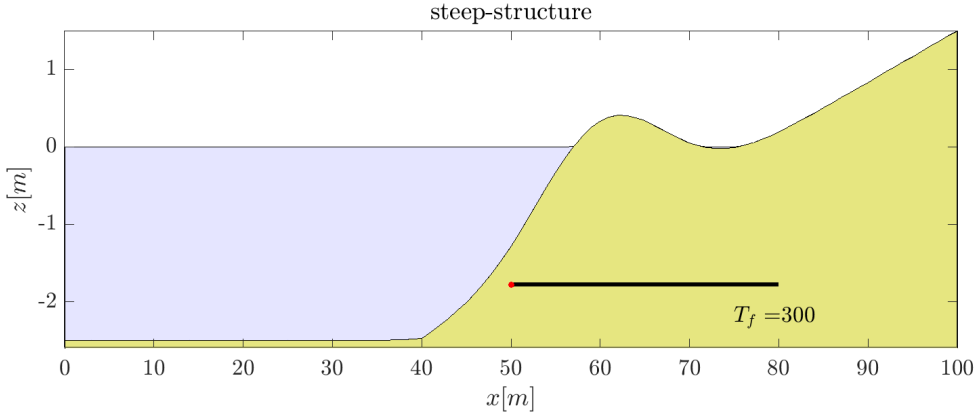
USACE Engineering Research and Devlelopment Center



Feb, 2025

Challenges

In cases of large slope and super-critical flow (esp with large concavity), challenge with instability

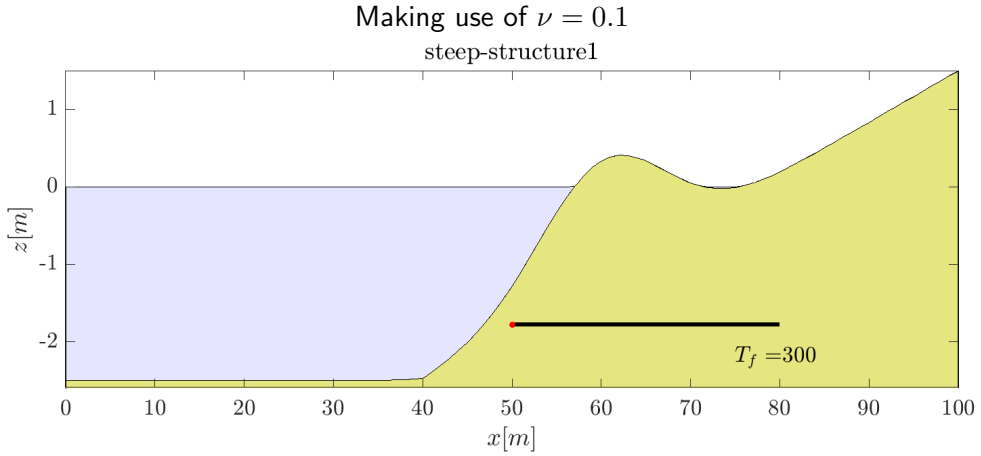


New Hydraulic Time-step Integration

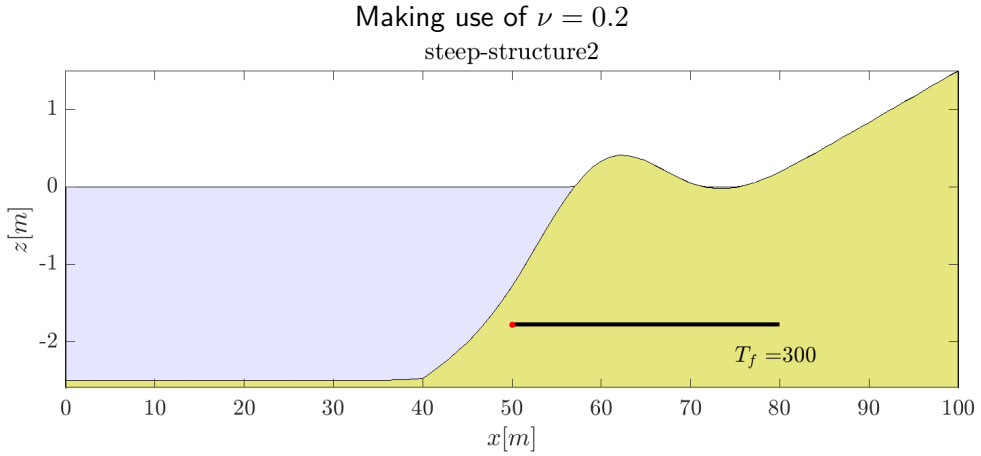
Within `shallow_water_moving_shore.m`, integrate in time from time-step k to $k+1$:

- Compute wave transformation and stresses
- Predict q^{k+1} on the basis of q^k, h^k using momentum conservation
- $\hat{q}_i^{k+1} = (1-\nu)q_i^{k+1} + \frac{\nu}{2}(q_{i+1}^{k+1} + q_{i-1}^{k+1}) \qquad 0 \leq \nu < 0.5 \quad \text{for} \quad max(Fr) > 1$
- $\hat{h}_i^{k} = (1-\nu)h_i^{k} + \frac{\nu}{2}(h_{i+1}^{k} + h_{i-1}^{k}) \qquad 0 \leq \nu < 0.5 \quad \text{for} \quad max(Fr) > 1$
- Restore wet/dry conditions that preceded smoothing
- Predict h^{k+1} on the basis of $\hat{q}^{k+1}, \hat{h}^k$ using mass conservation

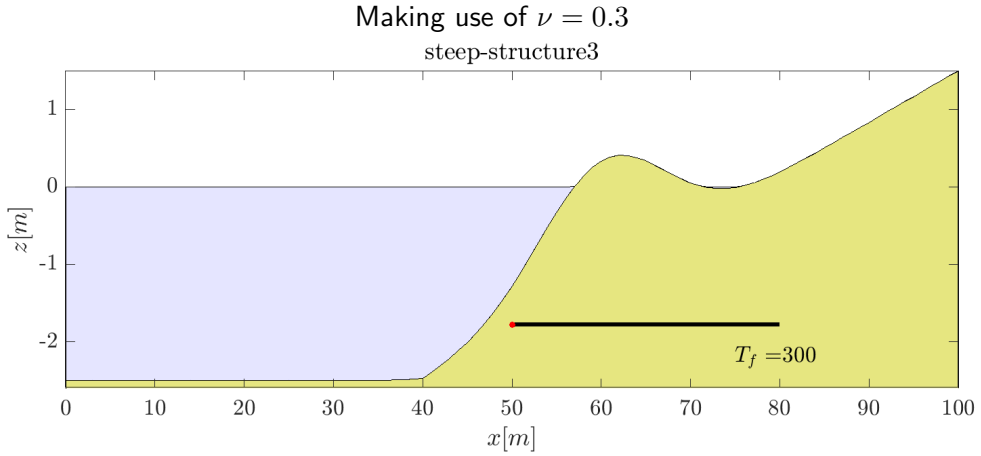
Challenges


Making use of $\nu = 0.1$
steep-structure1
$z[m]$
$x[m]$
T_f =300
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

Challenges


Making use of $\nu = 0.2$
steep-structure2
$z[m]$
$x[m]$
T_f =300
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

Challenges


Making use of $\nu = 0.3$
steep-structure3
$z[m]$
1
0
-1
-2
T_f =300
0
10
20
30
40
50
60
70
80
90
100
$x[m]$

CHARTS Morphology Component Options

All model Challenges:

- Usability: e.g. GUI including MC. etc
- Combining erosive/accretionary modes
- Logistics: e.g. Programming language, OS independence, etc

Model	Deficiency	Remedy	Risk
CSHORE	Hard-bottom	Recast sand conservation	Moderate/High
	Upland dynamics	Dev/Code improvement	Moderate
	Lacks 2DH	Dev	Moderate
CHANLSW	Swash characterization	Develop closure	Low/Moderate
	Computational efficiency	?GPU?	Moderate/High
	Morpho not verified	Comp model/data	Moderate/High
	Lacks 2DH	Dev	Moderate
2DH: D3D CMS	Upland dynamics	None	
	Computational Efficiency	ML	High
2DH:XBeach	Computational Efficiency	ML	High