

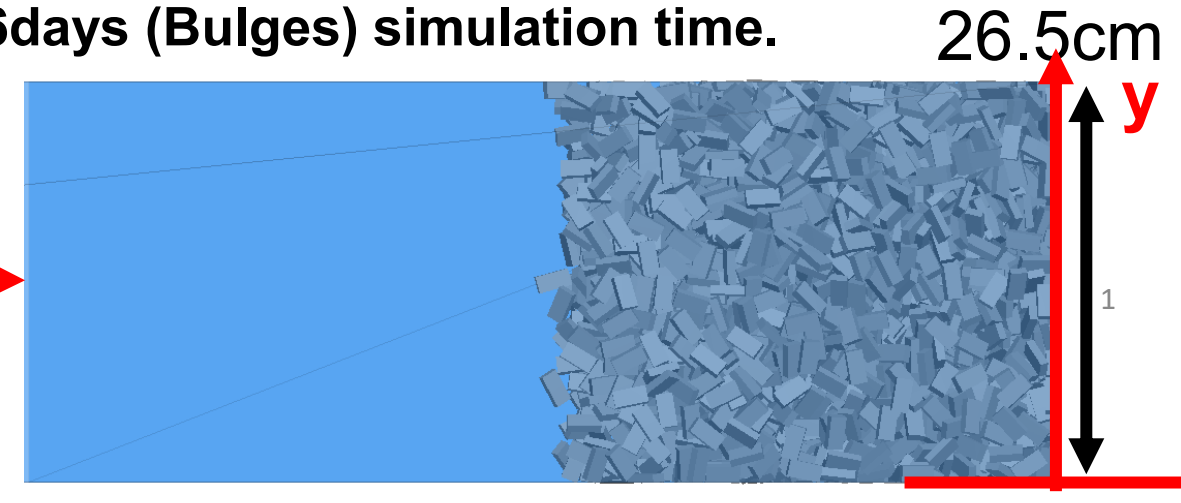
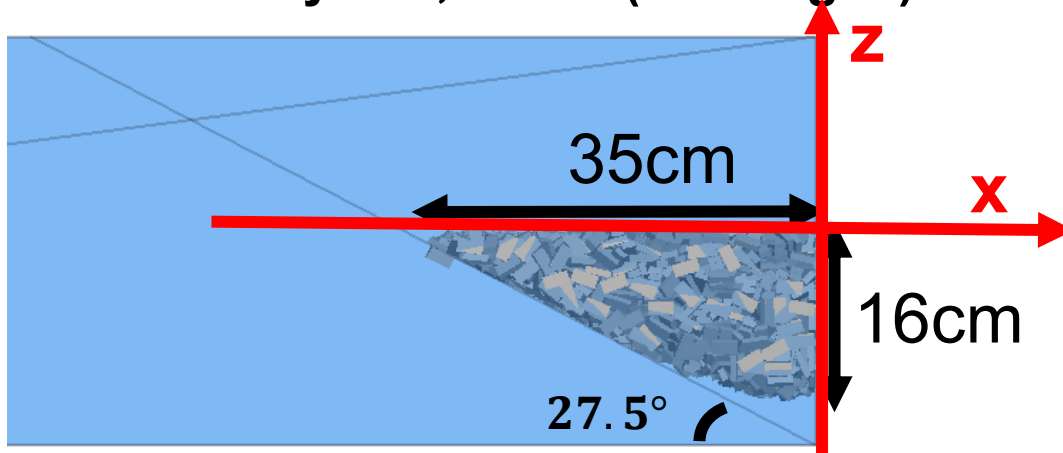
Validation from discrete element model

DEM 3D model (experimental scale, rectangles)

- Tank $L=2\text{m}$, **$W=26.5\text{cm}$** , $H=30\text{cm}$;
- Waterline height= 20cm ;
- Monodisperse rectangles: $2.54\text{cm} \times 1.27\text{cm} \times 0.635\text{cm}$;
- **$N=2526$ particles;**
- $\rho_s=920\text{kg/m}^3$, $\rho_w=997\text{kg/m}^3$;
- $v_{ter} = 0.62 \text{ mm/s}$;
- Hertz contact, $G= 10\text{kPa}$, $\nu = 0.3$;
- $\mu_p = 0.6$ (*angle of repose 30 deg*), **$\mu_w = 0.7$** ;
- Local damping ratio $\alpha = 0.5$;
- Contact viscous damping ratio $\beta_n = \beta_s = 0.7$;
- Fluid drag coefficient $C_w = 0.5$;
- Modeling timestep $\delta t_{mech} = 2e^{-4}\text{s}$, $T_{mod} = 1200\text{s}$;
- **6e6 mechanical cycles, 12hrs (no Bulges) & 3.6days (Bulges) simulation time.**

Implementation of wall friction:

**Add bulges on the wall ($0.5\text{cm} \times 0.5\text{cm} \times 0.2\text{cm}$);
spacing 0.4cm ; μ_w remains 0.7 in this case.**



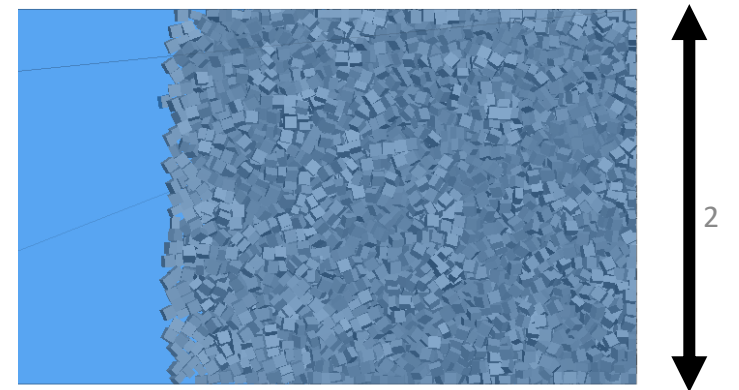
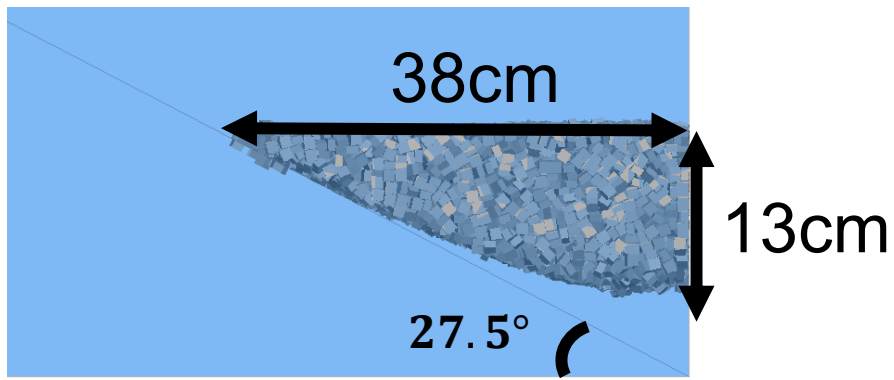
Validation from discrete element model

DEM 3D model (experimental scale, squares)

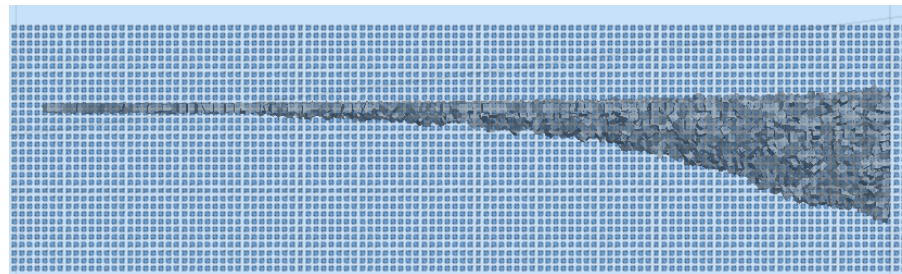
- Tank L=2m, **W=26.5cm**, H=30cm;
- Waterline height=20cm;
- Monodisperse rectangles: 0.9525cm x 0.9525cm x 0.635cm;
- **N=9161 particles**;
- $\rho_s=920\text{kg/m}^3$, $\rho_w=997\text{kg/m}^3$;
- $v_{ter} = 0.62 \text{ mm/s}$;
- Hertz contact, $G= 10\text{kPa}$, $\nu = 0.3$;
- $\mu_p = 0.6(\text{angle of repose } 30 \text{ deg})$, $\mu_w = 0.7$;
- Local damping ratio $\alpha = 0.5$;
- Contact viscous damping ratio $\beta_n = \beta_s = 0.7$;
- Fluid drag coefficient $C_w = 0.5$;
- Modeling timestep $\delta t_{mech} = 2e^{-4}\text{s}$, $T_{mod} = 1200\text{s}$;
- **6e6 mechanical cycles, 1.7days (no Bulges) & 5.7days (Bulges) simulation time. 26.5cm**

Implementation of wall friction:

**Add bulges on the wall (0.5cm x 0.5cm x 0.2cm);
spacing 0.4cm; μ_w remains 0.7 in this case.**

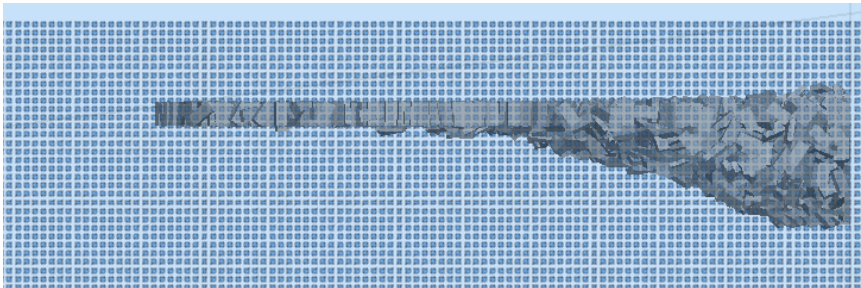


Square: with bulges

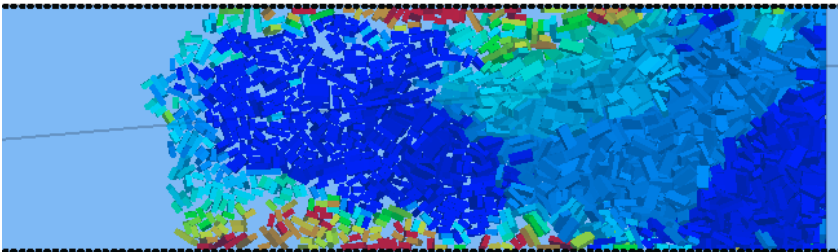
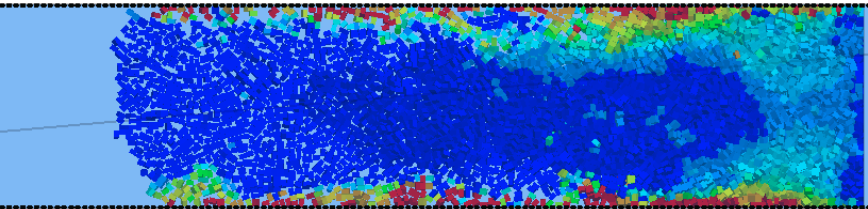
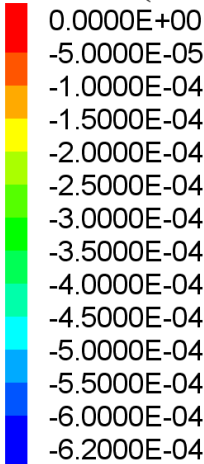


$t = 1200 \text{ s}$

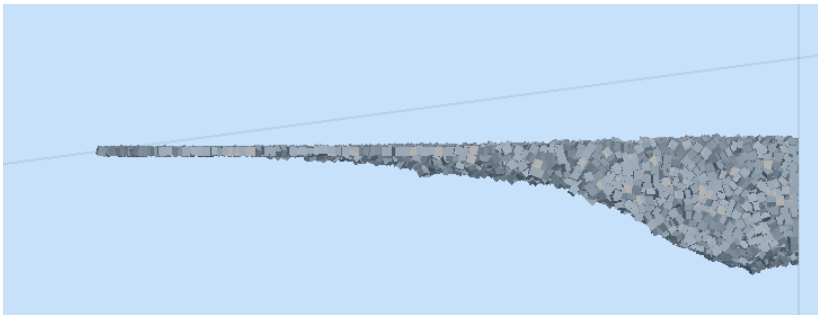
Rect: with bulges



RBlock velocity_x
RBlocks (8988)



Square: no bulges



Rect: no bulges

