1 Energy in DB

$$\mathcal{H}(t) = \frac{1}{2}\int_{-\infty}^{\infty} hu^2 + gh^2 + \frac{h^3}{3}\left(\frac{\partial u}{\partial x}\right)^3 \, dx$$

For the DB $u = 0$ and

$$h(x,0) = h_0 + \frac{h_1 - h_0}{2}\left(1 + \tanh\left(\alpha\left(x_0 - x\right)\right)\right)$$

at t=0 so

$$\mathcal{H}(0) = \frac{1}{2}\int_{-\infty}^{\infty} gh^2 \, dx$$

$$\mathcal{H}(0) = \frac{1}{2}\int_{-\infty}^{\infty} g\left(h_0 + \frac{h_1 - h_0}{2}\left(1 + \tanh\left(\alpha\left(x_0 - x\right)\right)\right)\right)^2 \, dx$$

$$\mathcal{H}(0) = \frac{g}{2}\int_{-\infty}^{\infty} h_0^2 + 2h_0\frac{h_1 - h_0}{2}\left(1 + \tanh\left(\alpha\left(x_0 - x\right)\right)\right) + \left(\frac{h_1 - h_0}{2}\right)^2\left(1 + \tanh\left(\alpha\left(x_0 - x\right)\right)\right)^2 \, dx \quad (1)$$

$$\mathcal{H}(0) = \frac{g}{2}\int_{-\infty}^{\infty} h_0^2 + h_0(h_1 - h_0)\left(1 + \tanh\left(\alpha\left(x_0 - x\right)\right)\right) + \left(\frac{h_1 - h_0}{2}\right)^2\left(1 + 2\tanh\left(\alpha\left(x_0 - x\right)\right) + \tanh\left(\alpha\left(x_0 - x\right)\right)^2\right) \, dx \quad (2)$$

$h_0 = 1$ $h_1 = 1.8$

$$\mathcal{H}(0) = \frac{g}{2}\int_{-\infty}^{\infty} 1 + 0.8\left(1 + \tanh\left(\alpha\left(x_0 - x\right)\right)\right) + 0.16\left(1 + 2\tanh\left(\alpha\left(x_0 - x\right)\right) + \tanh\left(\alpha\left(x_0 - x\right)\right)^2\right) \, dx \quad (3)$$

$$\mathcal{H}(0) = \frac{g}{2}\int_{-\infty}^{\infty} 1 + 0.8\left(1\right) + 0.16\left(1\right) \, dx + \frac{g}{2}\int_{-\infty}^{\infty} 0.8\left(\tanh\left(\alpha\left(x_0 - x\right)\right)\right) + 0.16\left(2\tanh\left(\alpha\left(x_0 - x\right)\right) + \tanh\left(\alpha\left(x_0 - x\right)\right)^2\right) \, dx \quad (4)$$

$$\mathcal{H}(0) = \frac{g}{2}\int_{-\infty}^{\infty} 1.96\, dx + \\ \frac{g}{2}\int_{-\infty}^{\infty} 1.12\left(\tanh\left(\alpha\left(x_0 - x\right)\right)\right) + 0.16\left(\tanh\left(\alpha\left(x_0 - x\right)\right)^2\right)\, dx \quad (5)$$

$$\mathcal{H}(0) = \frac{g}{2}\int_{-\frac{\Delta x}{2}}^{1000+\frac{\Delta x}{2}} 1.96\, dx + \\ \frac{g}{2}\int_{-\frac{\Delta x}{2}}^{1000+\frac{\Delta x}{2}} 1.12\left(\tanh\left(\alpha\left(500 - x\right)\right)\right) + 0.16\left(\tanh\left(\alpha\left(500 - x\right)\right)^2\right)\, dx \quad (6)$$

$$\mathcal{H}(0) = 1.96\frac{g}{2}(1000 + \Delta x) + \\ \frac{g}{2}\int_{-\frac{\Delta x}{2}}^{1000+\frac{\Delta x}{2}} 1.12\left(\tanh\left(\alpha\left(500 - x\right)\right)\right)\, dx + \frac{g}{2}\int_{-\frac{\Delta x}{2}}^{1000+\frac{\Delta x}{2}} 0.16\left(\tanh\left(\alpha\left(500 - x\right)\right)^2\right)\, dx \quad (7)$$

The integral of tanh is 0 over the interval as its odd around dambreak (at the center).

$$\mathcal{H}(0) = 1.96\frac{g}{2}(1000 + \Delta x) + \frac{g}{2}\int_{-\frac{\Delta x}{2}}^{1000+\frac{\Delta x}{2}} 0.16\left(\tanh\left(\alpha\left(500 - x\right)\right)^2\right)\, dx \quad (8)$$

$$\mathcal{H}(0) = 1.96\frac{g}{2}(1000 + \Delta x) + 0.16\frac{g}{2}\int_{0}^{1000} \tanh\left(\alpha\left(500 - x\right)\right)^2\, dx \quad (9)$$

$$g = 9.81$$

$$\mathcal{H}(0) = 9.6138(1000 + \Delta x) + 0.7848 \times \int_{-\frac{\Delta x}{2}}^{1000+\frac{\Delta x}{2}} \tanh\left(\alpha\left(500 - x\right)\right)^2\, dx \quad (10)$$

$$\mathcal{H}(0) = 9.6138(1000+\Delta x)+0.7848\times\left[x+\frac{\tanh\left(\alpha\times(500-x)\right)}{\alpha}\right]_{-\frac{\Delta x}{2}}^{1000+\frac{\Delta x}{2}} \tag{11}$$

$$\mathcal{H}(0) = 9.6138(1000+\Delta x)+$$
$$0.7848\times\left[1000+\frac{\Delta x}{2}+\frac{\tanh\left(\alpha\times(500-1000-\frac{\Delta x}{2})\right)}{\alpha}+\frac{\Delta x}{2}-\frac{\tanh\left(\alpha\times(500+\frac{\Delta x}{2})\right)}{\alpha}\right] \tag{12}$$

$$\mathcal{H}(0) = 9.6138(1000+\Delta x)+$$
$$0.7848\times\left[1000+\Delta x+\frac{\tanh\left(\alpha\times(-\left(500+\frac{\Delta x}{2}\right))\right)}{\alpha}-\frac{\tanh\left(\alpha\times(500+\frac{\Delta x}{2})\right)}{\alpha}\right] \tag{13}$$

Since tanh is odd

$$\mathcal{H}(0) = 9.6138(1000+\Delta x)+$$
$$0.7848\times\left[1000+\Delta x-\frac{2}{\alpha}\tanh\left(\alpha\times\left(500+\frac{\Delta x}{2}\right)\right)\right] \tag{14}$$

$$\mathcal{H}(0) = 9.6138(1000+\Delta x)+0.7848\times(1000+\Delta x)+$$
$$0.7848\times\left[1000+\Delta x-\frac{2}{\alpha}\tanh\left(\alpha\times\left(500+\frac{\Delta x}{2}\right)\right)\right] \tag{15}$$

$$\mathcal{H}(0) = 10.3986(1000+\Delta x)+$$
$$0.7848\times\left[1000+\Delta x-\frac{2}{\alpha}\tanh\left(\alpha\times\left(500+\frac{\Delta x}{2}\right)\right)\right] \tag{16}$$