3維空隙物質內微小振幅波運動

1. 支配方程式

透水性防波堤或護岸等空隙物質內波運動，假定受與加速度成正比，及與流速有關抵抗作用時，將前者影響包含於空隙物質空隙率，稱之為假想空隙率V，將後者視為與流速成正比，其係數以μ表示。空隙內流體領域局部空間平均水平及垂直方向流速以u^*、v^*及w^*表示，流體壓力及密度以p^*及ρ表示，則連續方程式可以下式表示

$$\frac{\partial u^*}{\partial x}+\frac{\partial v^*}{\partial y}+\frac{\partial w^*}{\partial z}=0 \qquad (1)$$

x、y及z方向運動方程式可分別以下式表示

$$\left.\begin{aligned}\frac{\partial u^*}{\partial t}&=-\frac{1}{\rho}\frac{\partial p^*}{\partial x}-\frac{\mu}{V}u^*\\ \frac{\partial v^*}{\partial t}&=-\frac{1}{\rho}\frac{\partial p^*}{\partial y}-\frac{\mu}{V}v^*\\ \frac{\partial w^*}{\partial t}&=-\frac{1}{\rho}\frac{\partial p^*}{\partial z}-\frac{\mu}{V}w^*-g\end{aligned}\right\} \qquad (2)$$

依(1)及(2)式所示流體運動具有速度

$$\Phi_*(x,y,z;t)=\frac{g\zeta_o}{\sigma}\phi_*(x,y,z)\exp(-i\,\sigma t)$$

$\phi_*(x,z)$ 滿足下列 Laplace 方程式

$$\frac{\partial^2\phi_*}{\partial x^2}+\frac{\partial^2\phi_*}{\partial y^2}+\frac{\partial^2\phi_*}{\partial z^2}=0$$

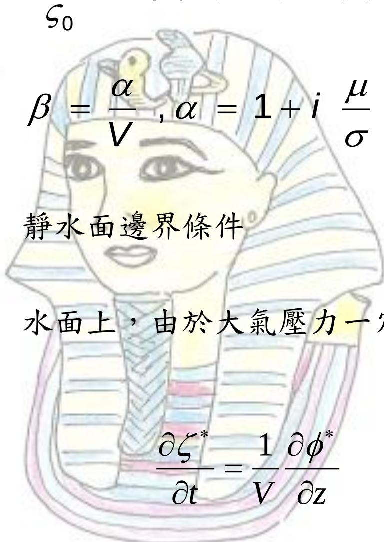
流速，壓力及水面波形分別以下式表示

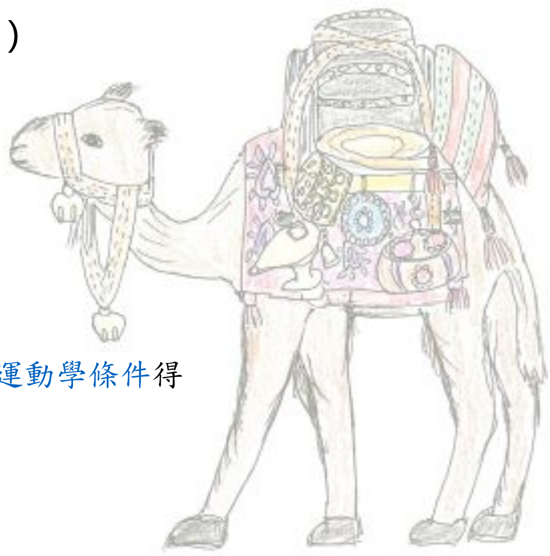
$$u^*=\partial\phi^*/\partial x,\ v^*=\partial\phi^*/\partial y,\ w^*=\partial\phi^*/\partial z$$

$$\frac{p^*}{\rho g \varsigma_0} = i\,\beta\phi^*(x,z)\,\exp(-i\,\sigma t)$$

$$\frac{\varsigma}{\varsigma_0} = i\,\beta\phi^*(x,0)\,\exp(-i\,\sigma t)$$

$$\beta = \frac{\alpha}{V},\ \alpha = 1 + i\,\frac{\mu}{\sigma}$$





載滿珠寶的駱駝

2. 靜水面邊界條件

水面上，由於大氣壓力一定及運動學條件得

$$\frac{\partial \varsigma^*}{\partial t} = \frac{1}{V}\frac{\partial \phi^*}{\partial z}$$

由上式得

$$\frac{\partial \phi^*}{\partial z} = \alpha\frac{\sigma^2}{g}\phi^*$$

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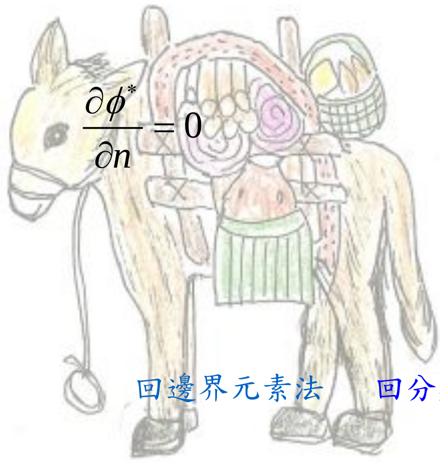
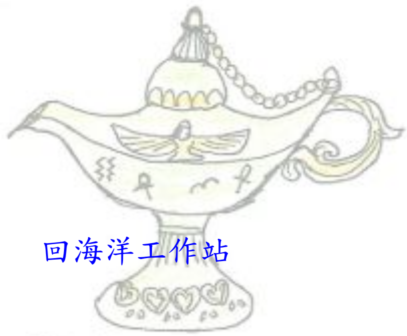
3. 固定不透水面邊界條件

$$\frac{\partial \phi^*}{\partial n} = 0$$



載滿貨品的驢子



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