UE Problem F4-5

Fall '07

d)

Parameters	Units
σ	$kg/m\text{-}s^2$
ρ_m	kg/m^3
g	m/s^2
ℓ	m

$N = 4,\ K = 3,\ N - K = 1$ Pi group

e) $\boxed{\Pi_1 = \dfrac{\sigma}{\rho_m g \ell}}$, other possibilities OK, eg $\dfrac{\rho_m g \ell}{\sigma}$, etc.

f) The dimensional relation $\sigma = f(\rho_m\ g\ \ell)$

became $\Pi_1 = \bar{f}(\,) = \text{constant}$ (no arguments)

This constant Π_1 can be measured from σ, ρ_m, ℓ of a model of any size ℓ or any density ρ_m. The actual-sculpture stress σ is then obtained by scaling.

$$\Pi_{actual} = \Pi_{model} = \frac{\sigma_{model}}{\rho_{m_{model}}\, g\, \ell_{model}} \quad \text{(measured)}$$

then...

$$\boxed{\sigma_{actual} = \rho_{m_{actual}} \cdot g \cdot \ell_{actual} \cdot \Pi_{model}}$$

or equivalently

$$\boxed{\sigma_{actual} = \sigma_{model} \cdot \frac{\rho_{m_{actual}} \cdot \ell_{actual}}{\rho_{m_{model}}\, \ell_{model}}}$$