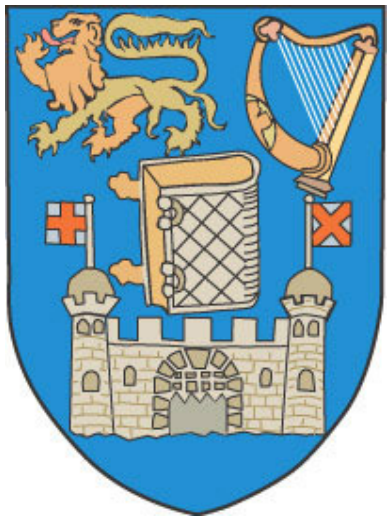
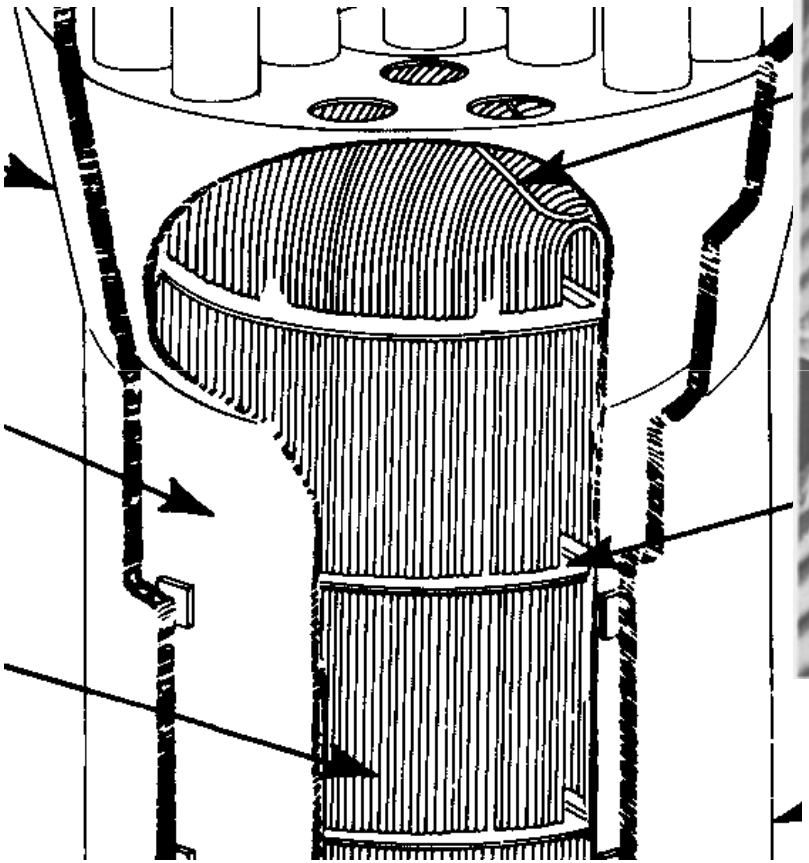
Flow Induced Vibration in Nuclear Steam Generators



Dan Keogh

Supervisor Dr. Craig Meskell

Background



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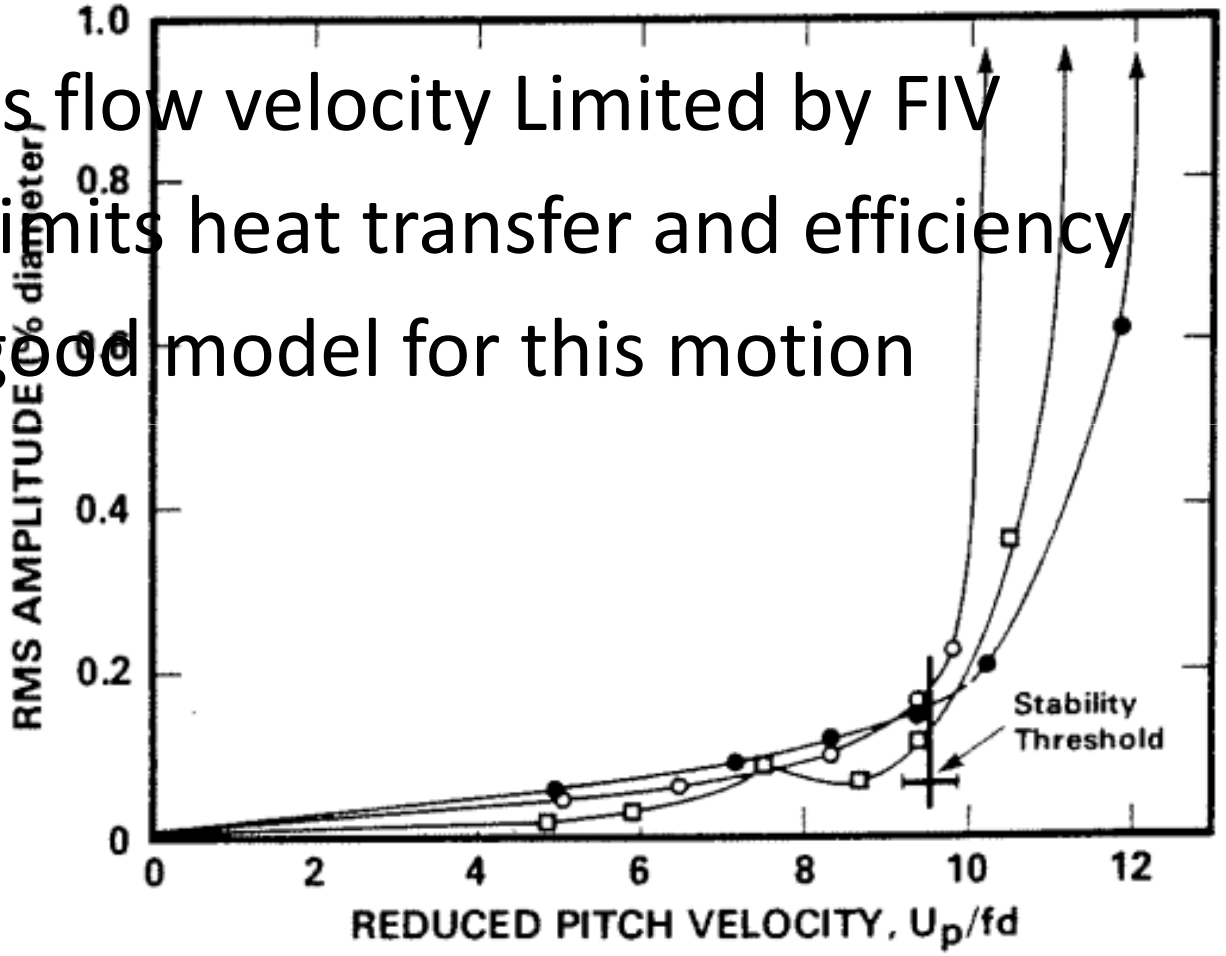
[www.nucleartourist.com]
[Shin & Wambsganss 1977]

Background

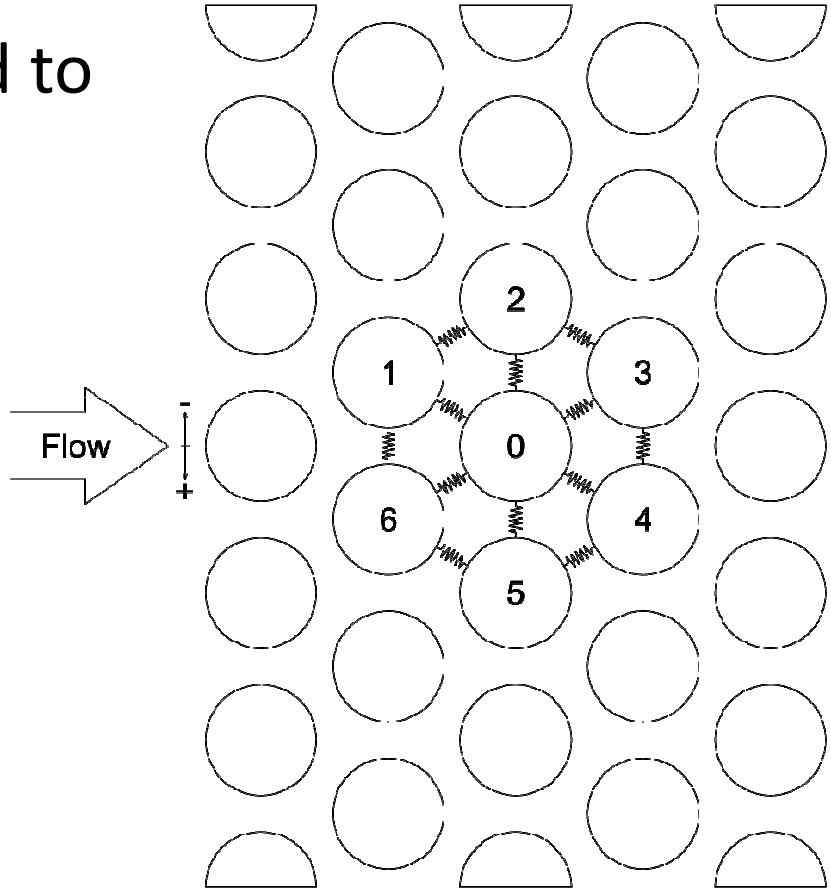
- Cross flow velocity Limited by FIV
- FIV limits heat transfer and efficiency
- No good model for this motion



[Lever & Weaver 1982]
[Price & Paidoussis 1984]

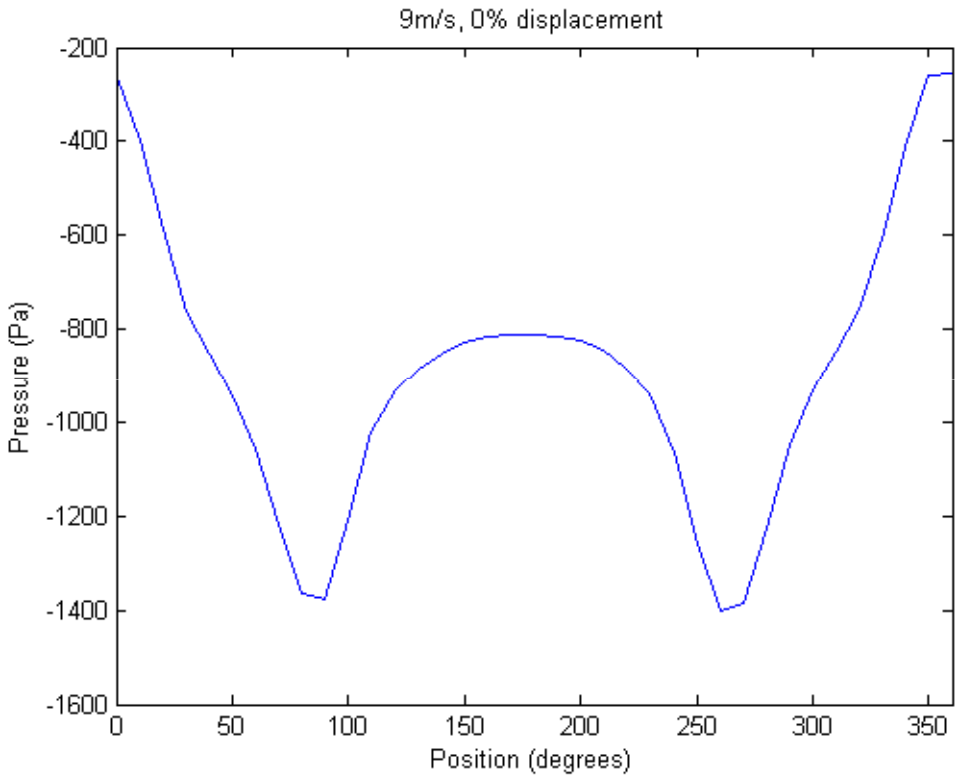
Approach

- Static displacement applied to tube 0
- Only interactions between tubes in the kernel are considered
- Springs represent fluid coupling
- Fluid forces non-linear



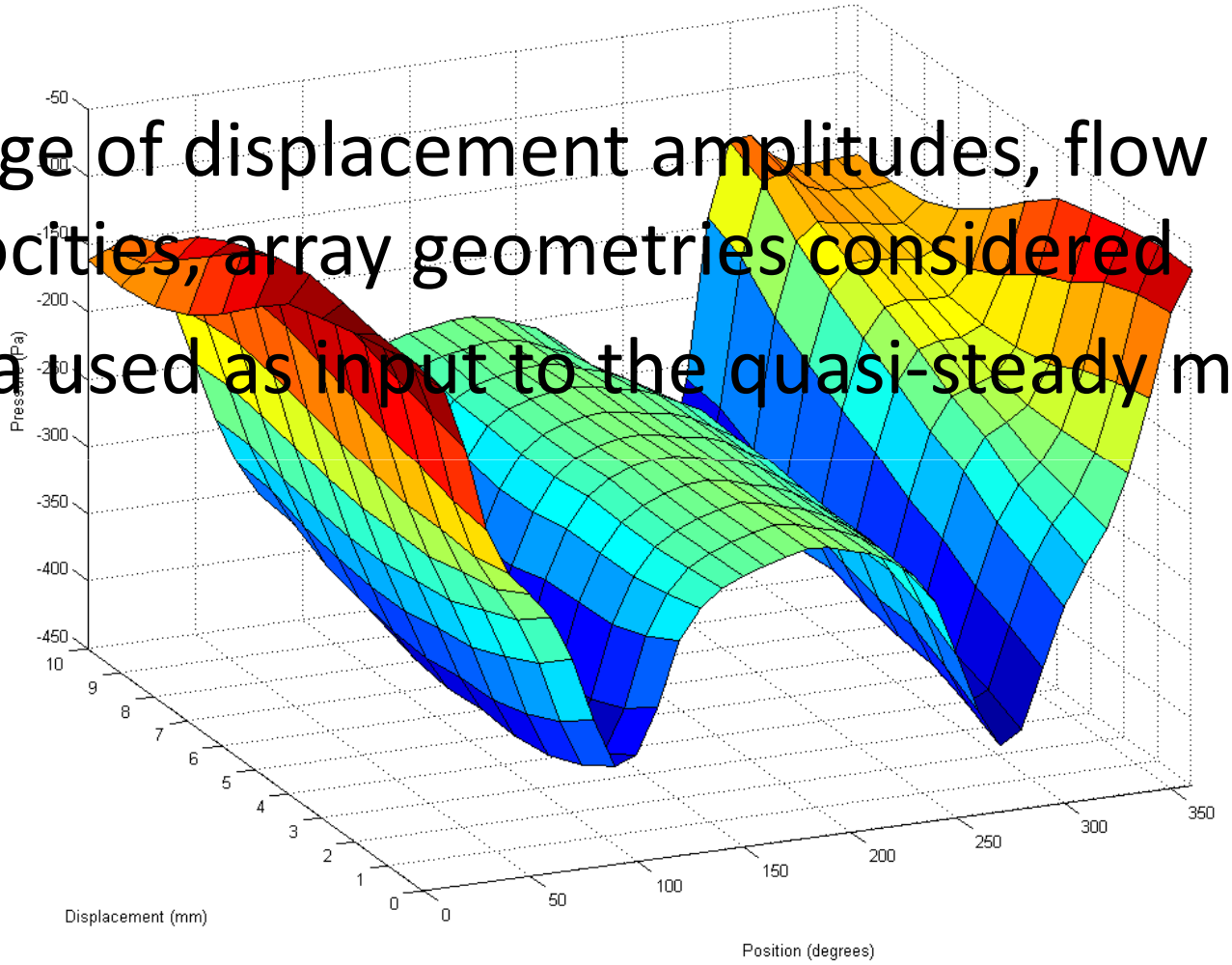
Preliminary Results

- Pressure measured at each tube location
- Coefficients of lift and drag determined by integration



Preliminary Results

- Range of displacement amplitudes, flow velocities, array geometries considered
- Data used as input to the quasi-steady model



Questions

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APPENDIX

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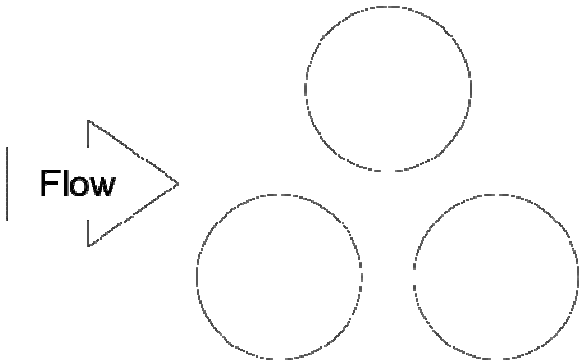
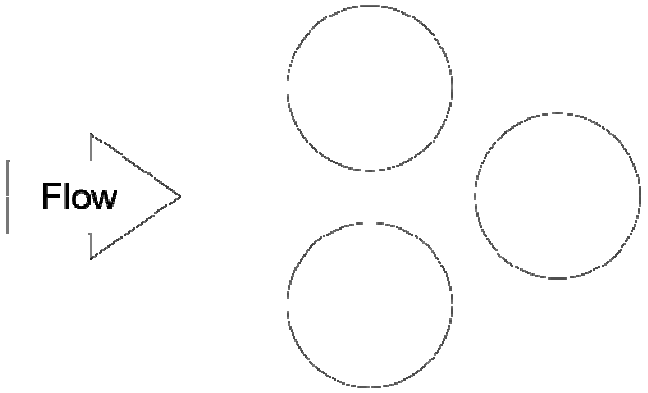
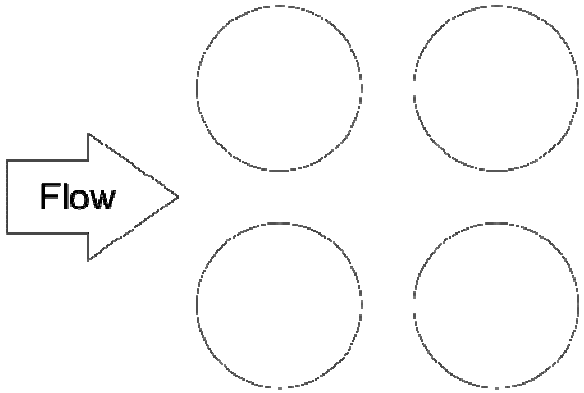


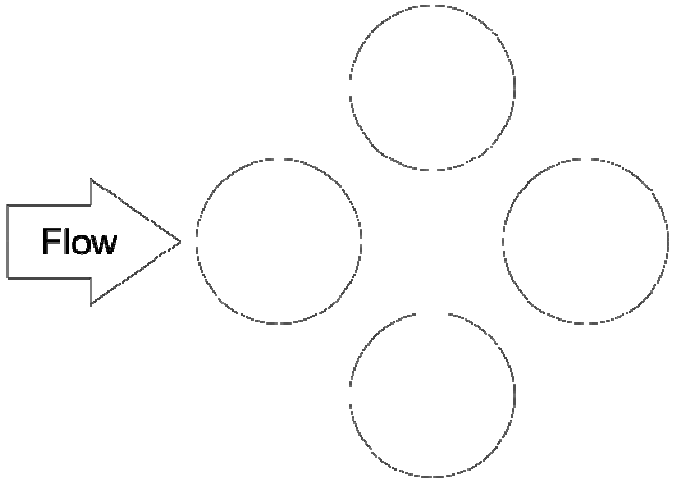
Rotated Triangular



Normal Triangular



In-line Square



Rotated Square

Equation of motion:

$$m\ddot{y} + c\dot{y} + ky = F_y(y, \dot{y}, \ddot{y}, U)$$

Fluid forces:

$$F_y = \frac{1}{2}\rho D l U_g^2 \left[C_L - \frac{\dot{x}D}{U_g} 2C_L - \frac{\dot{y}D}{U_g} C_D \right]$$

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[Price & Paidoussis 1984]

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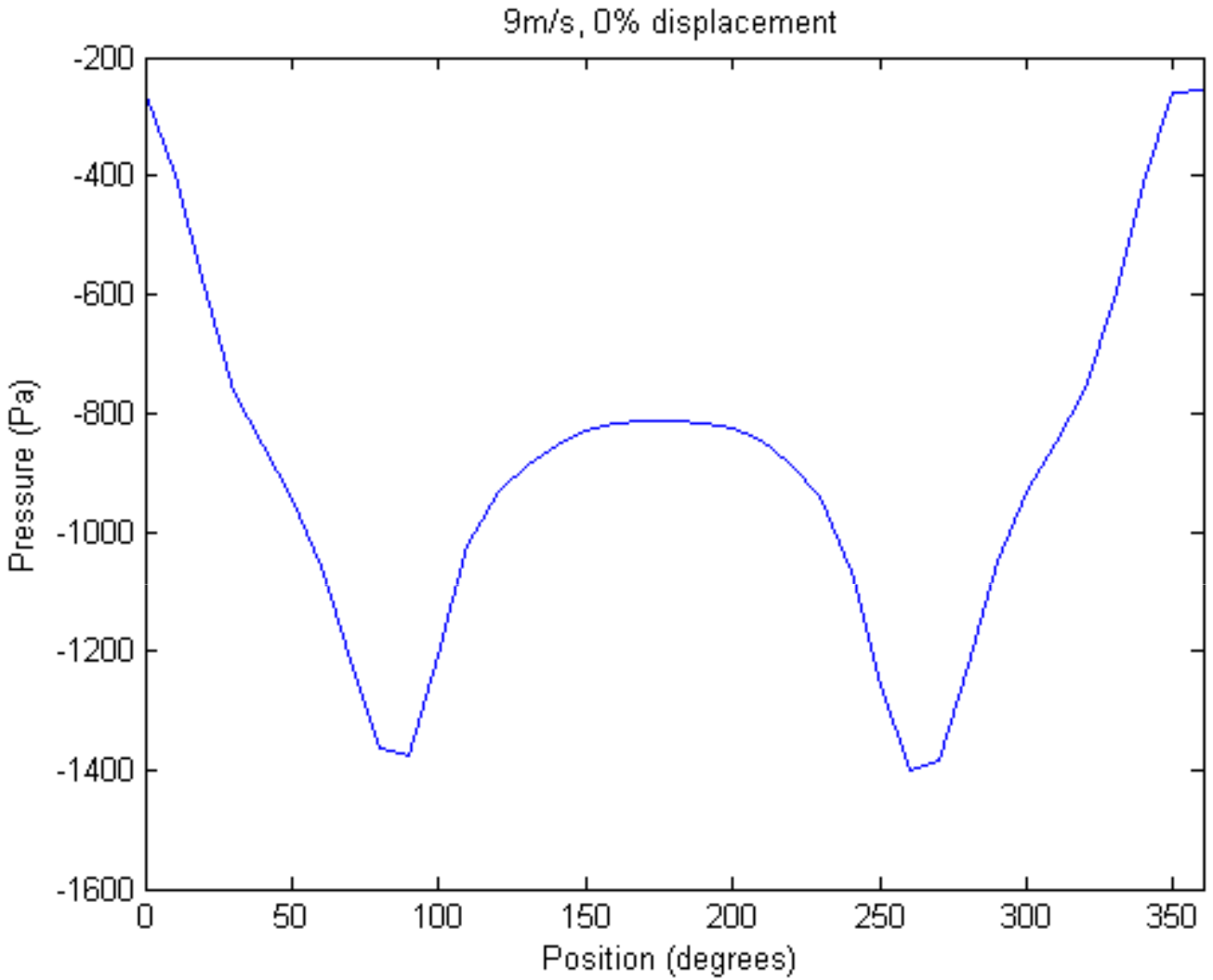
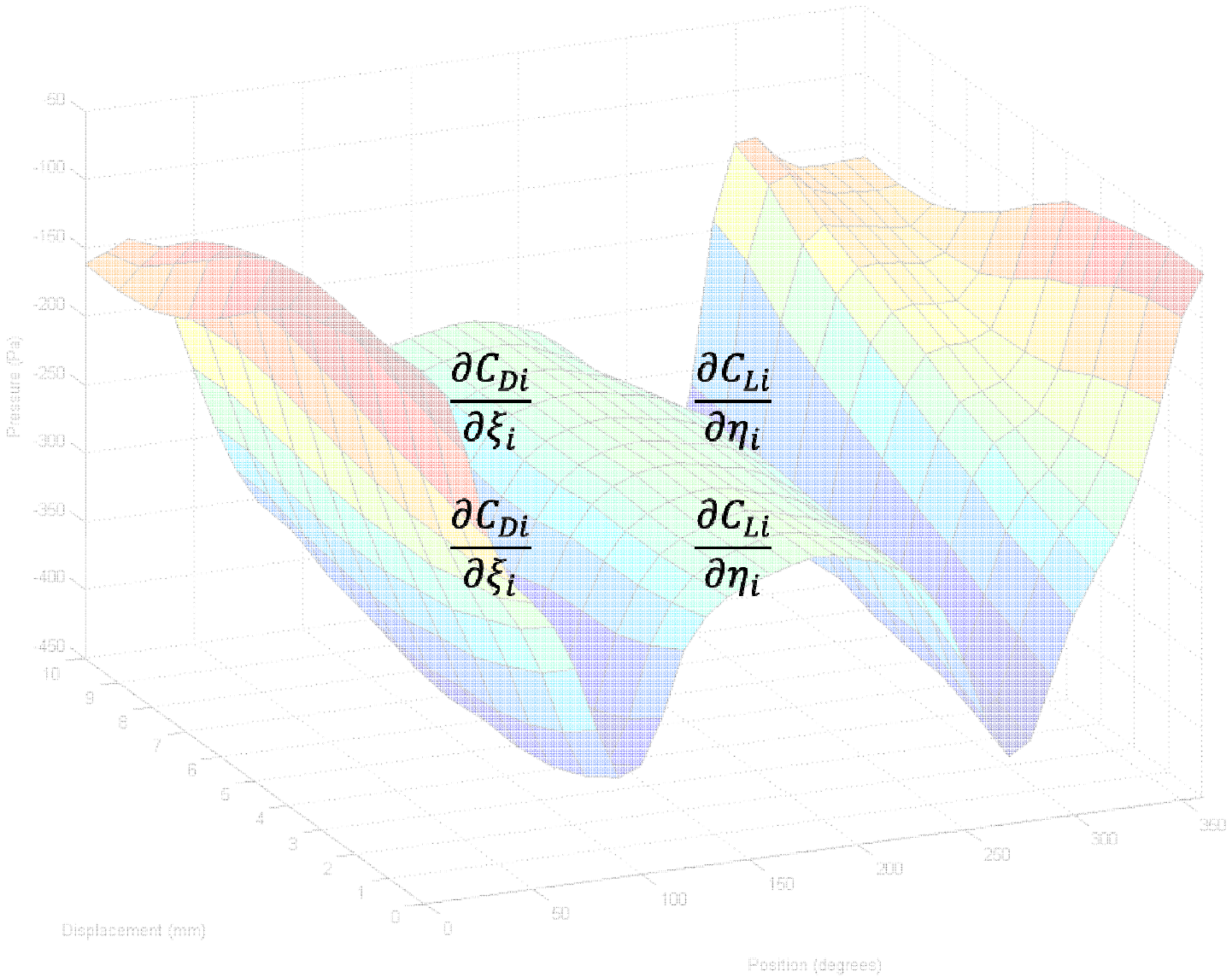


$$L = \int_0^{2\pi} P dl \sin(\theta) d\theta \qquad C_L = \frac{L}{\frac{1}{2}\rho dl U_g^2}$$

$$D = \int_0^{2\pi} P dl \cos(\theta) d\theta \qquad C_D = \frac{D}{\frac{1}{2}\rho dl U_g^2}$$



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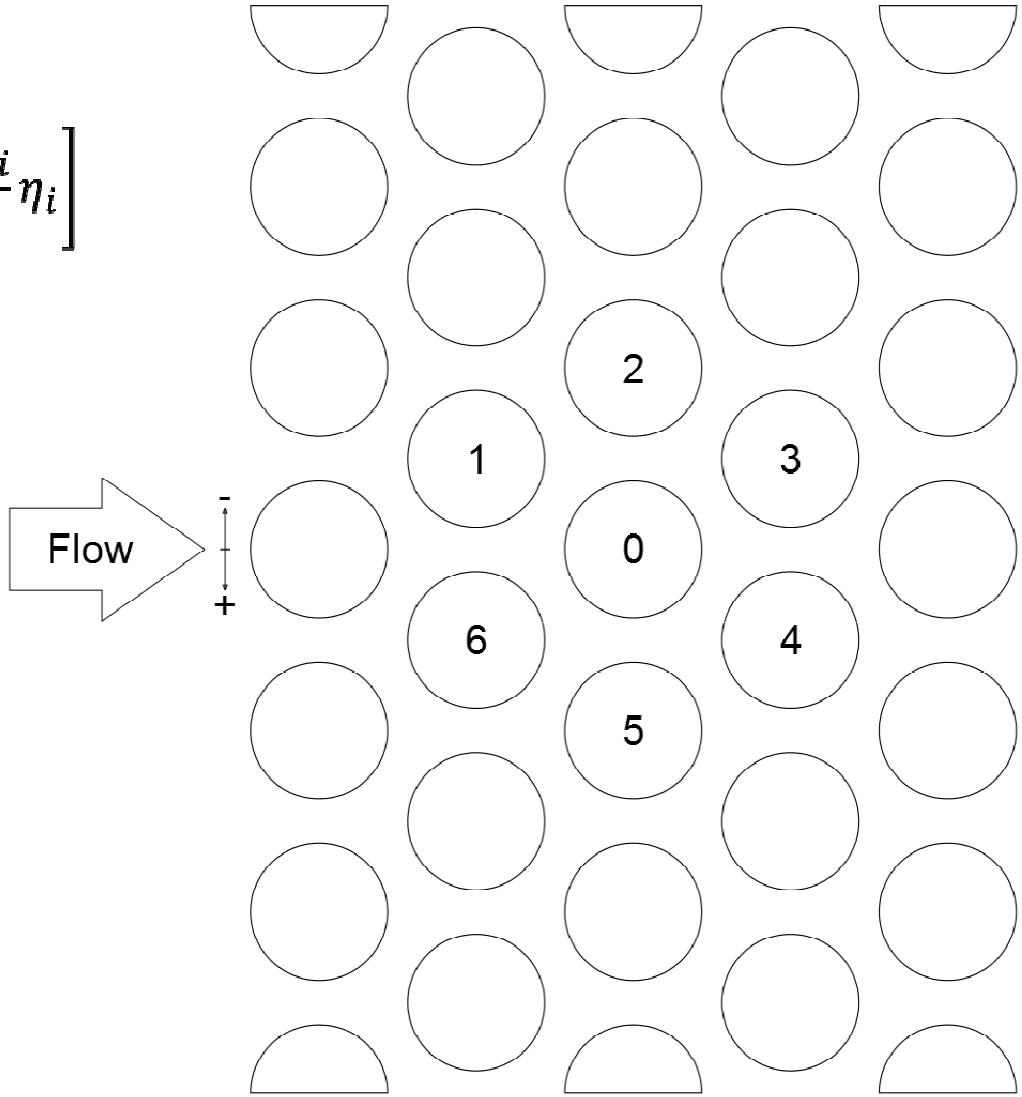
$$C_{Di} = C_{Di0} + \sum_{i=1}^{6} \left[\frac{\partial C_{Di}}{\partial \xi_i} \xi_i + \frac{\partial C_{Di}}{\partial \eta_i} \eta_i \right]$$



$$C_{Di} = C_{Di0} + \sum_{i=1}^{6}\left[\frac{\partial C_{Di}}{\partial \xi_i}\xi_i + \frac{\partial C_{Di}}{\partial \eta_i}\eta_i\right]$$

$$F_y = \frac{1}{2}\rho D l U_g^2\left[C_L - \frac{\dot{x}D}{U_g}2C_L - \frac{\dot{y}D}{U_g}C_D\right]$$

$$m\ddot{y} + c\dot{y} + ky = F_y(y, \dot{y}, \ddot{y}, U)$$