Localisation of Rayleigh–Bloch waves and damping of resonant loads on arrays of vertical cylinders

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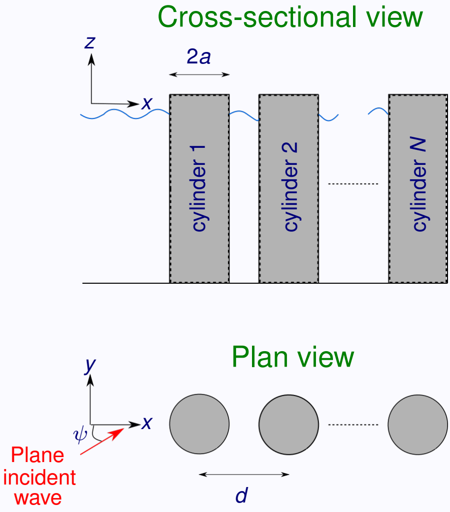
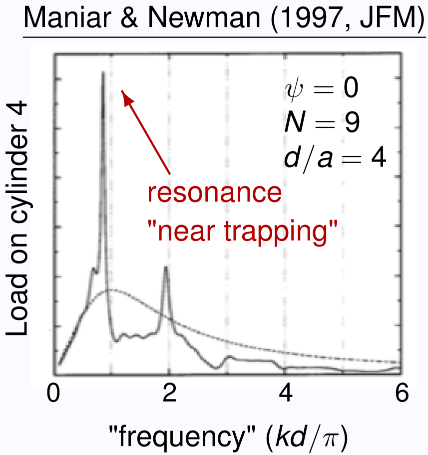
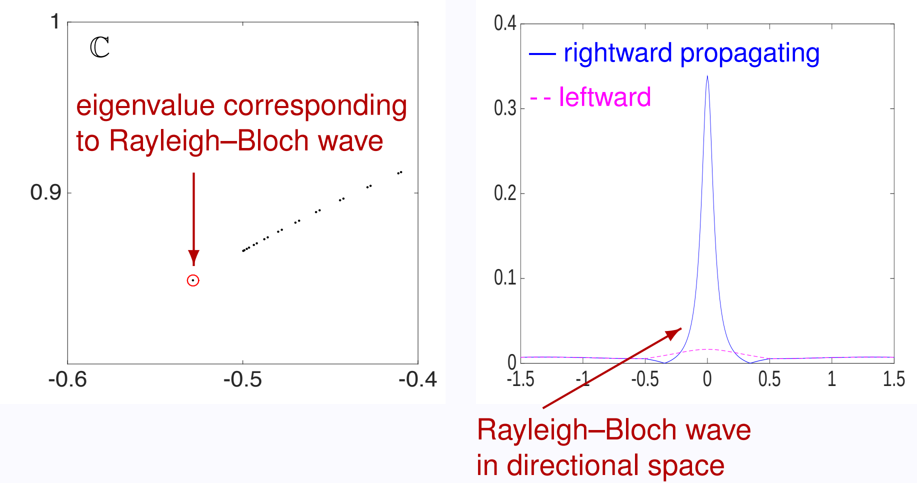
Journal of Fluid Mechanics, 2017, 813, 508–527

We consider a mathematical model of loads imposed by incident waves on line arrays of rigid, vertical, surface-piercing cylinders. Maniar & Newman (1997) and others previously showed that regular arrays experience resonant loads at certain frequencies.

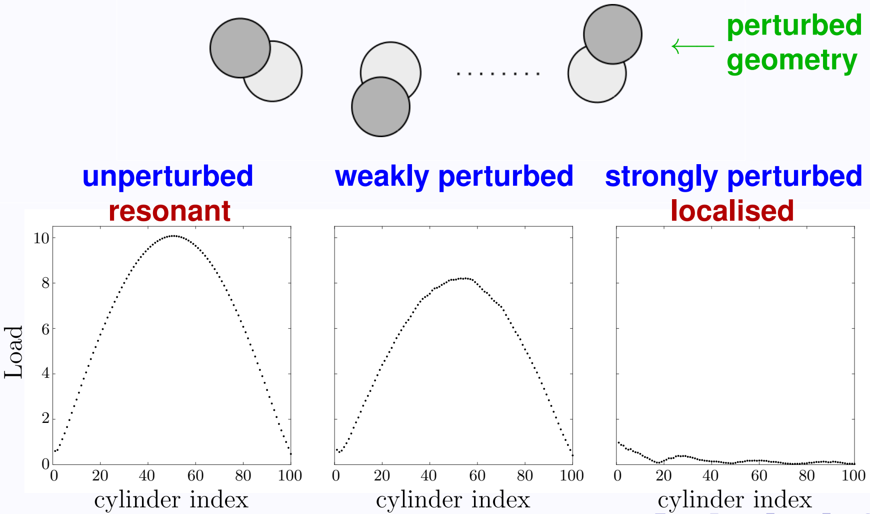




We develop a solution method that identifies the Rayleigh–Bloch wave modes responsible for the resonances, from the directional scattering characteristics of a solitary cylinder.

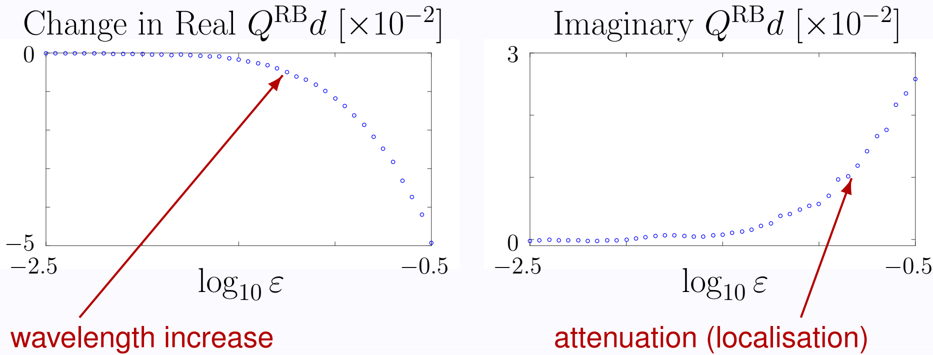


We use the method to study impacts of perturbing the cylinder locations from their regular arrangement. Weak perturbations are found to shift the resonant structure, slightly damping the loads on the array. Strong perturbations break the resonant structure, with the load profile reducing from the from of the array to the back, reminiscent of a localised state.

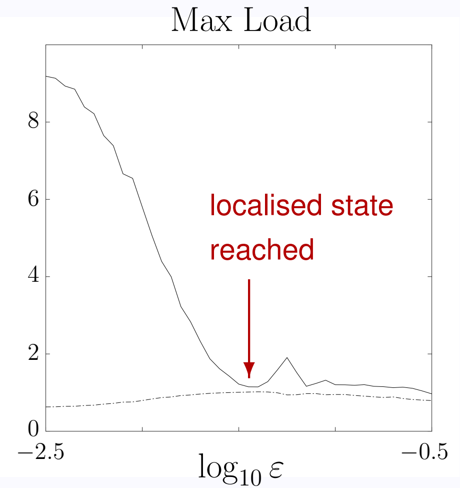


We extract properties of perturbed Rayleigh–Bloch waves supported by the perturbed arrays, and show that as the perturbation strength, ε, increases (i) the wavelength increases, and (ii) the waves begin to attenuate, resulting in the localisation.

$kd/\pi \approx 0.885$



We relate the localisation of Rayleigh–Bloch waves to damping of resonant loads, showing that the onset of attenuation/localisation coincides with the maximum load being attained at the front of the array.



$kd/\pi \approx 0.885$

—— Max load

– – – Load on $n = 1$