

Extreme Waves on Sheared Currents

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Background – Introductory Definitions

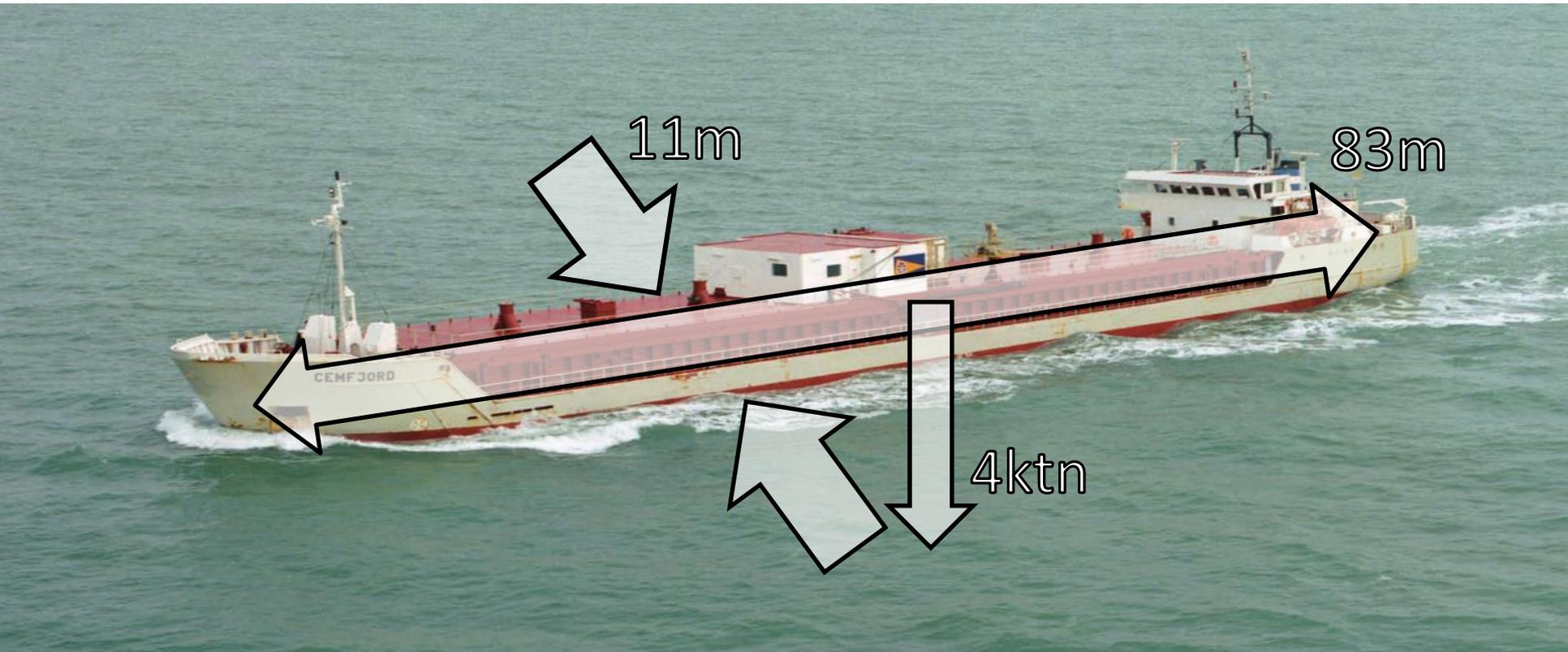
Wave Stability: Unstable regular wavetrains naturally evolve to become irregular

Sheared currents: Higher current velocities on the surface – almost zero velocity at the bed

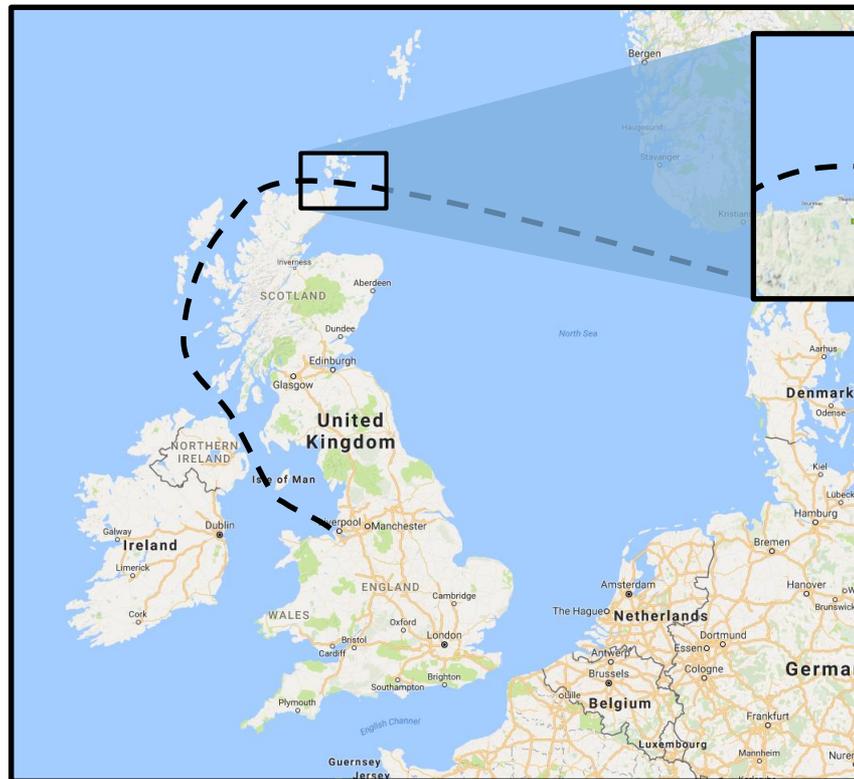
Linear shear: Constant change in velocity with depth,

$$\Omega = \frac{du}{dz}$$

Cemfjord – A Medium Sized Cement Carrier



Cemfjord – Journey through the Pentland Firth



2nd January, 13:15 - Stops transmitting it's Automatic Identification System



2014, 30th December – Leaves port of Rordal, Denmark

2nd January, 12:36 - Enters the Pentland Firth

3rd January, 14:16 – Hull of Cemfjord spotted

Cemfjord – The Investigation (MAIB)



“~~Such extraordinary weather predicted and conditions were~~
~~theater by the Gale Force winds opposing the strong~~
~~attempted”~~”

“*Cemfjord* capsized suddenly and rapidly when it encountered extraordinarily violent, breaking seas...”

Increase in wave steepness

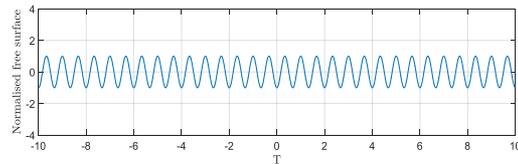
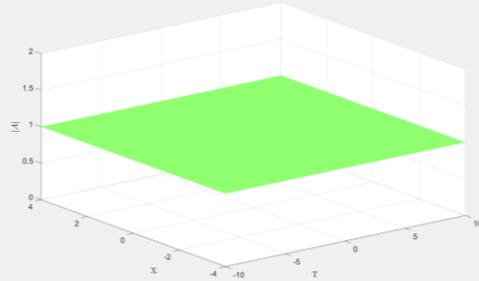
Waves become unstable



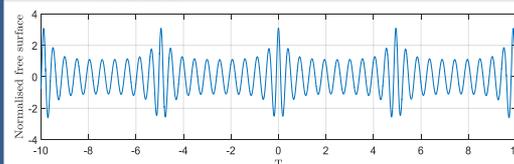
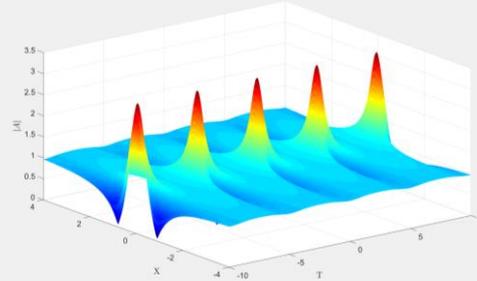
Modelling Unstable Wavetrains



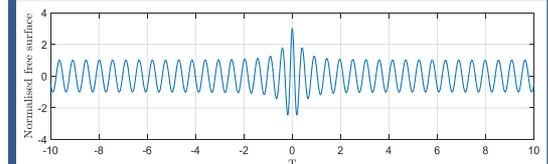
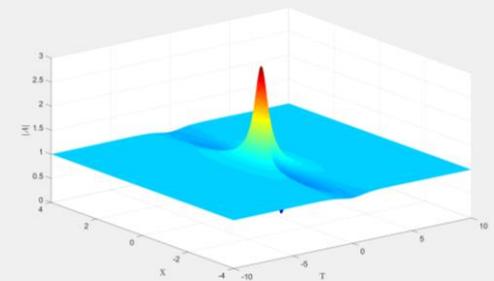
Stokes Solution
– Regular wave –



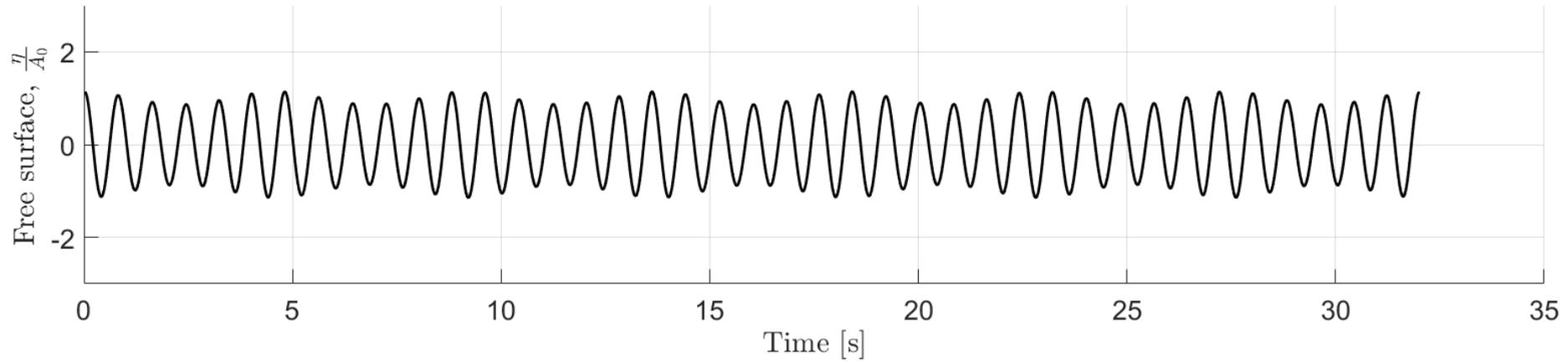
Akhmediev Breather
– Periodic breather –



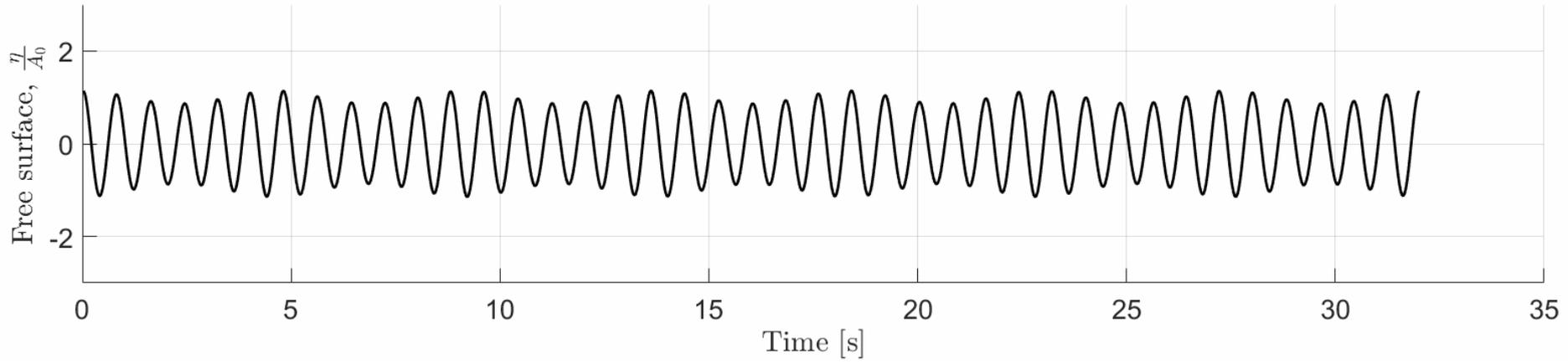
Peregrine Breather
– Localised breather –



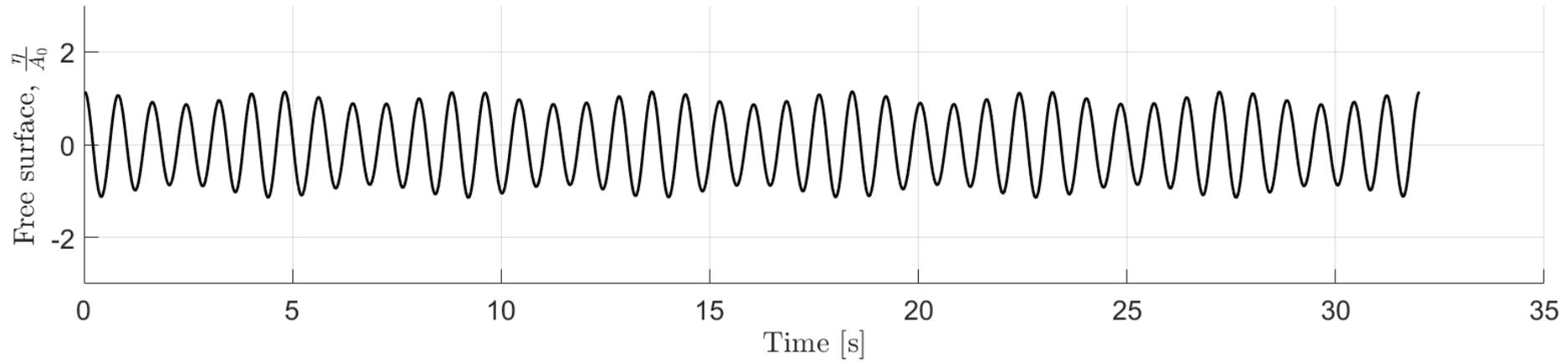
Stable wavetrain (on still water) at $x = 0.00$ m



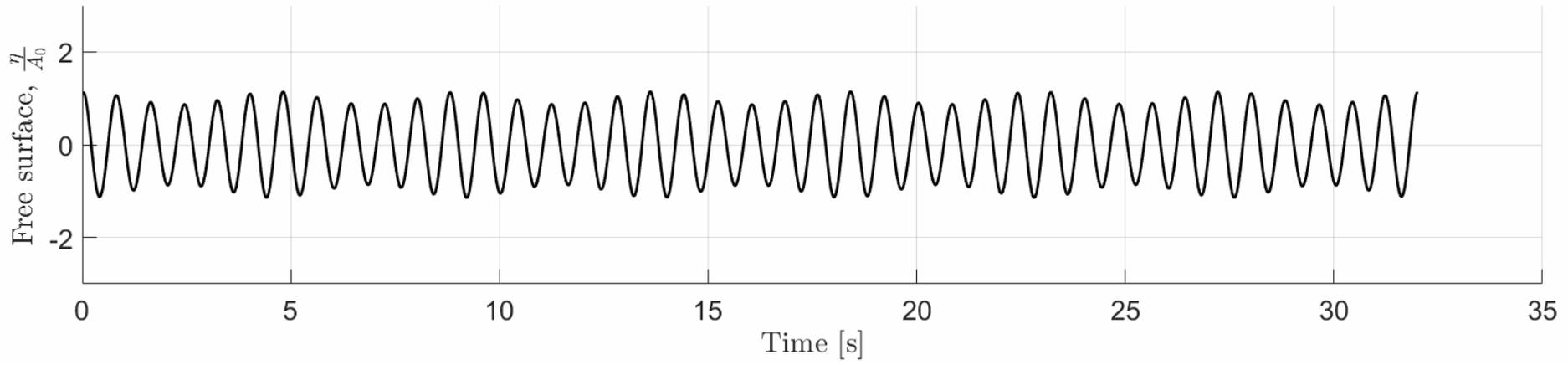
Stable wavetrain (on still water) at $x = 0.00$ m



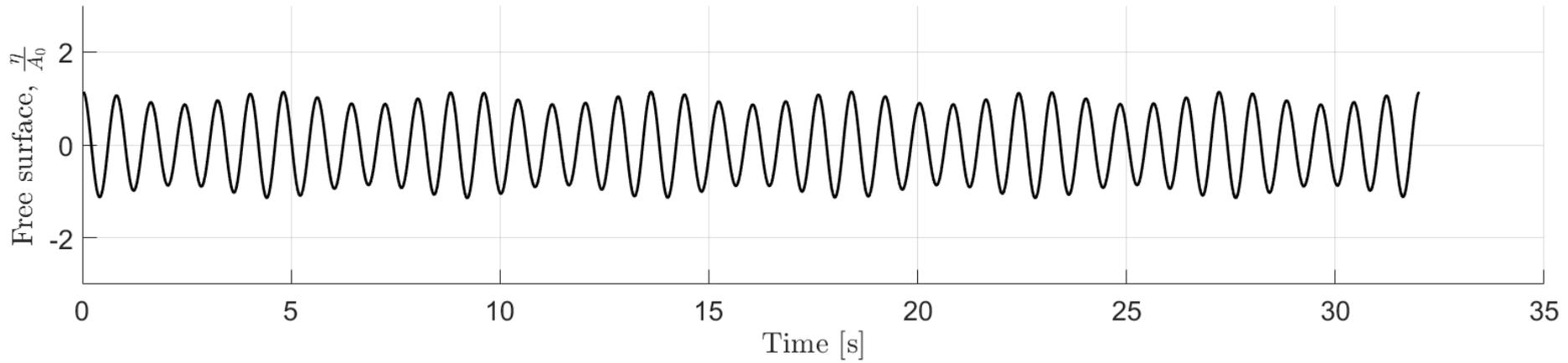
Unstable wavetrain on uniform current at $x = 0.00$ m



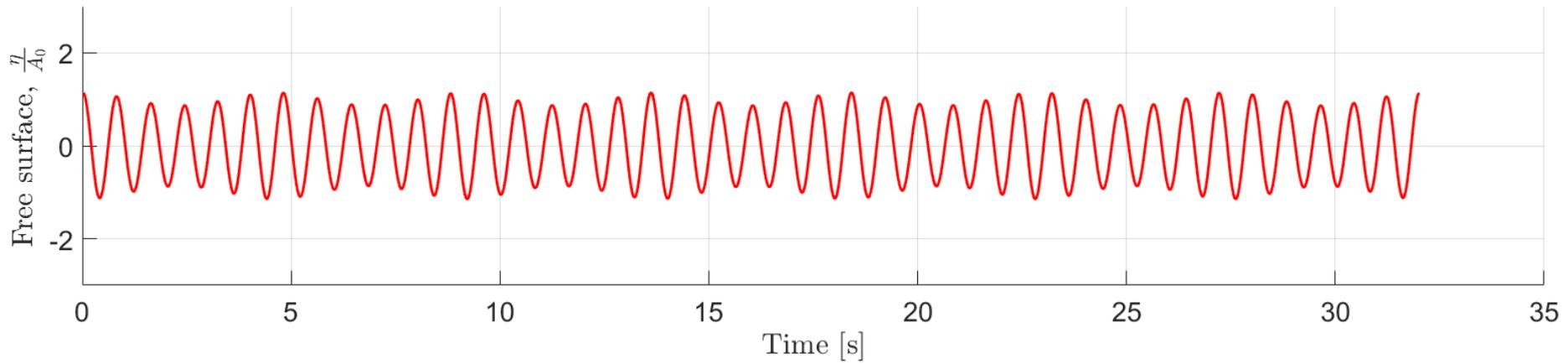
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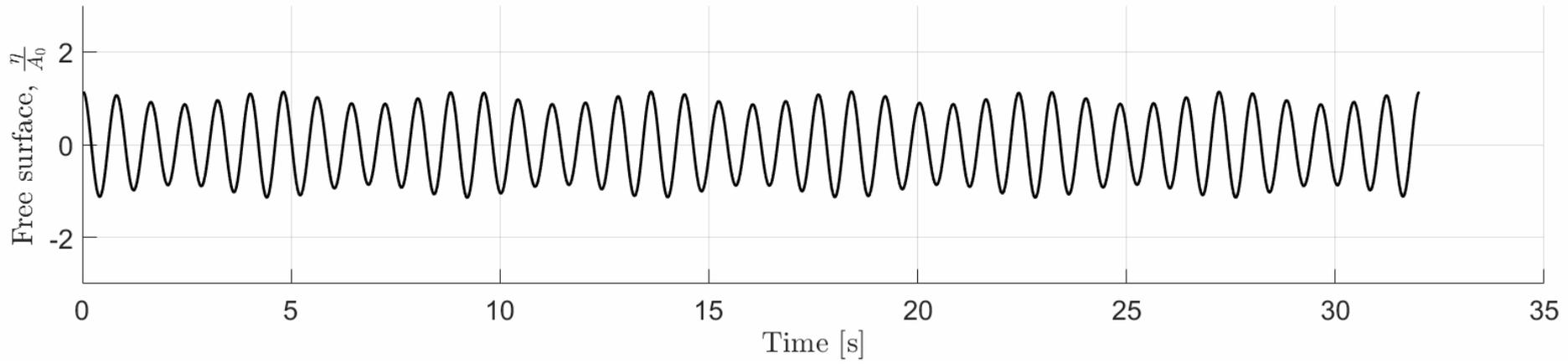
Unstable wavetrain on uniform current at $x = 0.00$ m



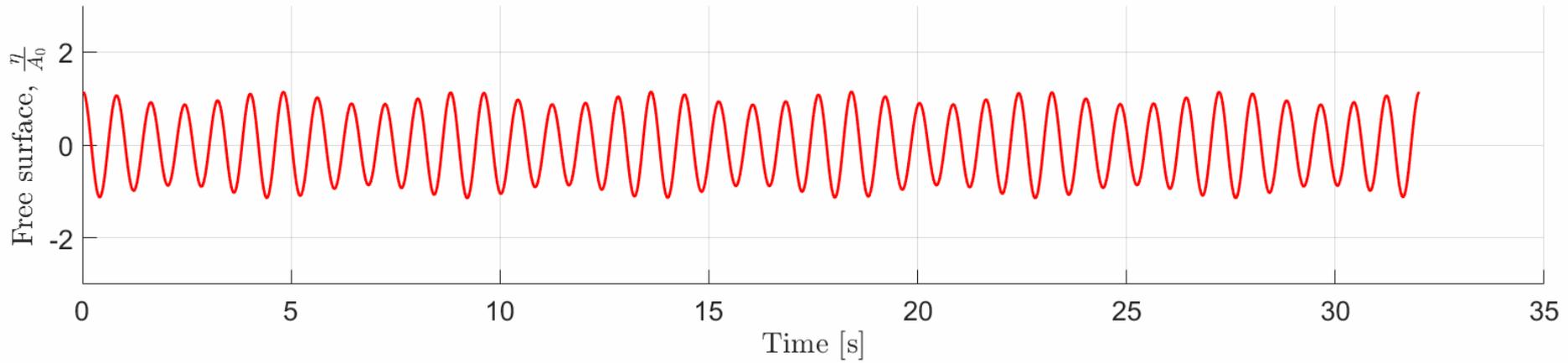
Unstable wavetrain on sheared current at $x = 0.00$ m



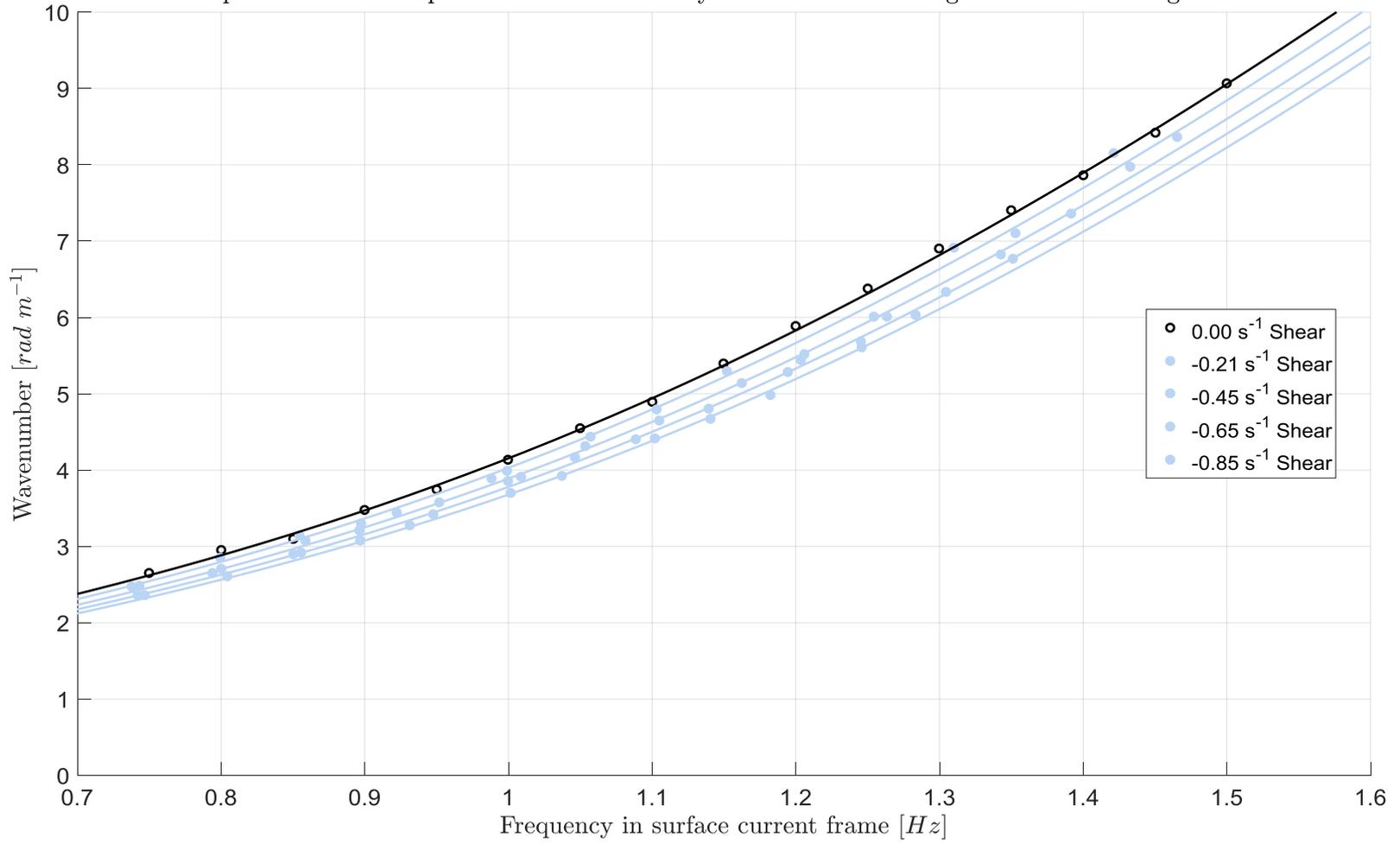
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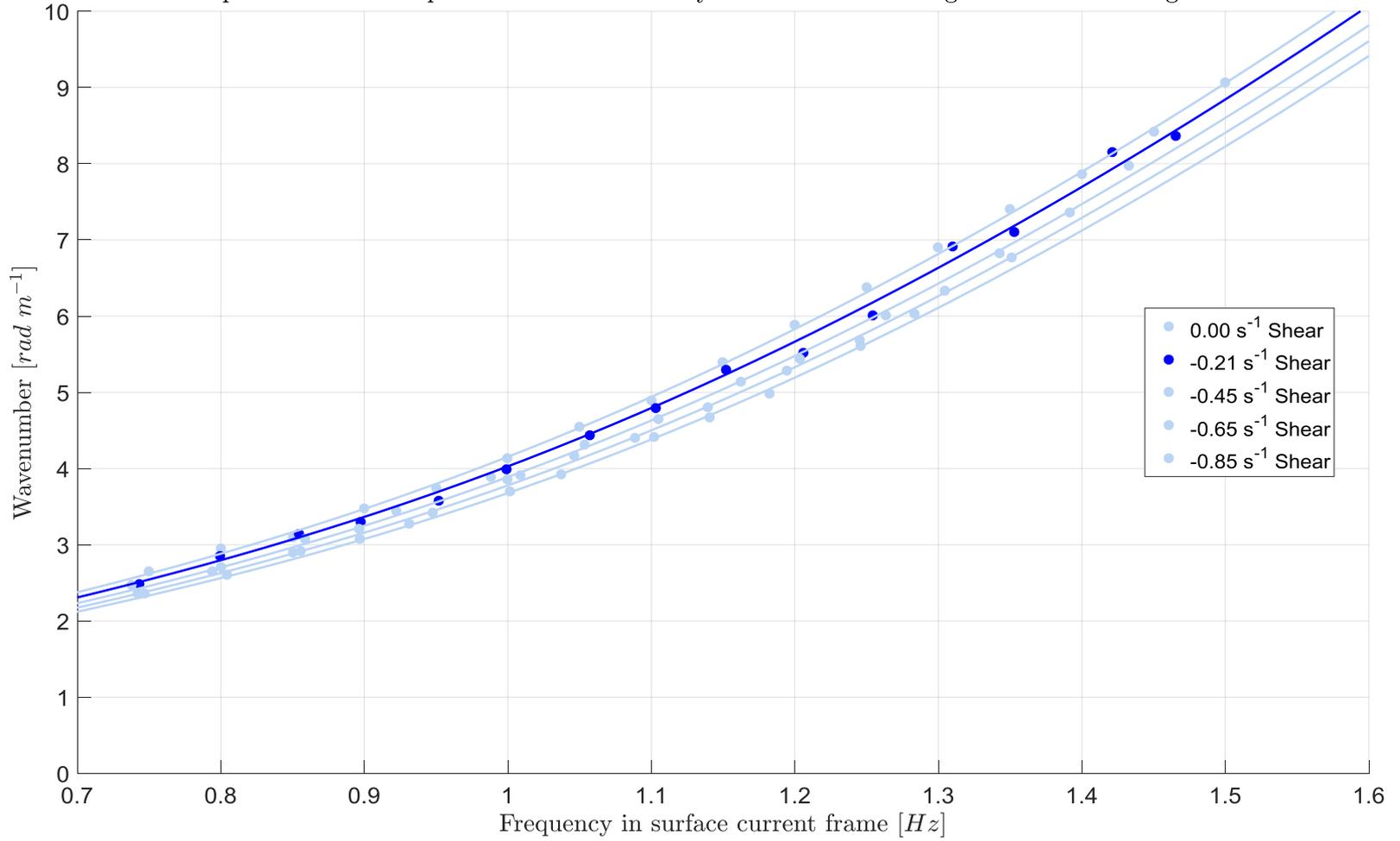
Unstable wavetrain on sheared current at $x = 0.00$ m



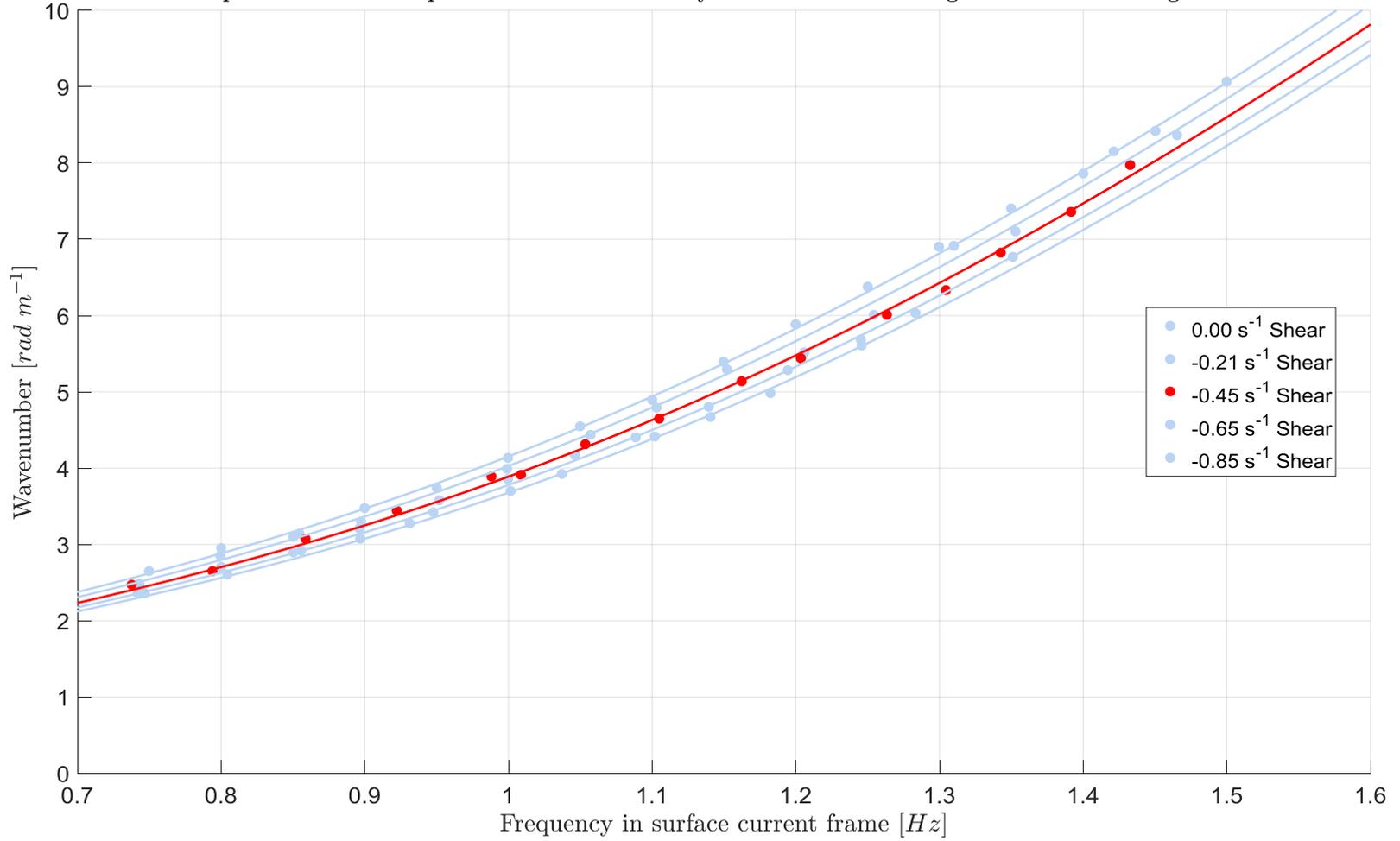
Dispersion relationship of waves on a vertically sheared current using measured wavelength data



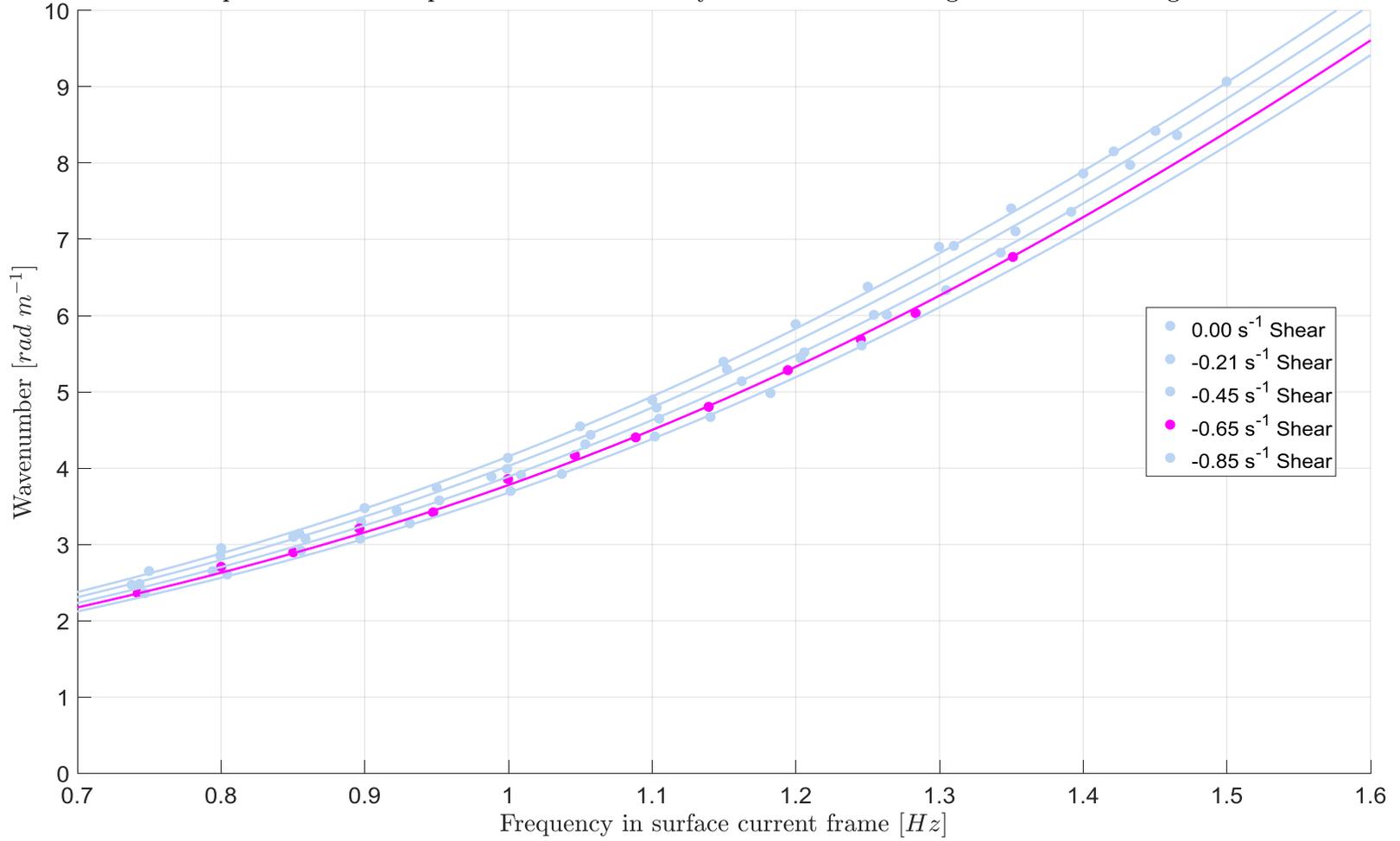
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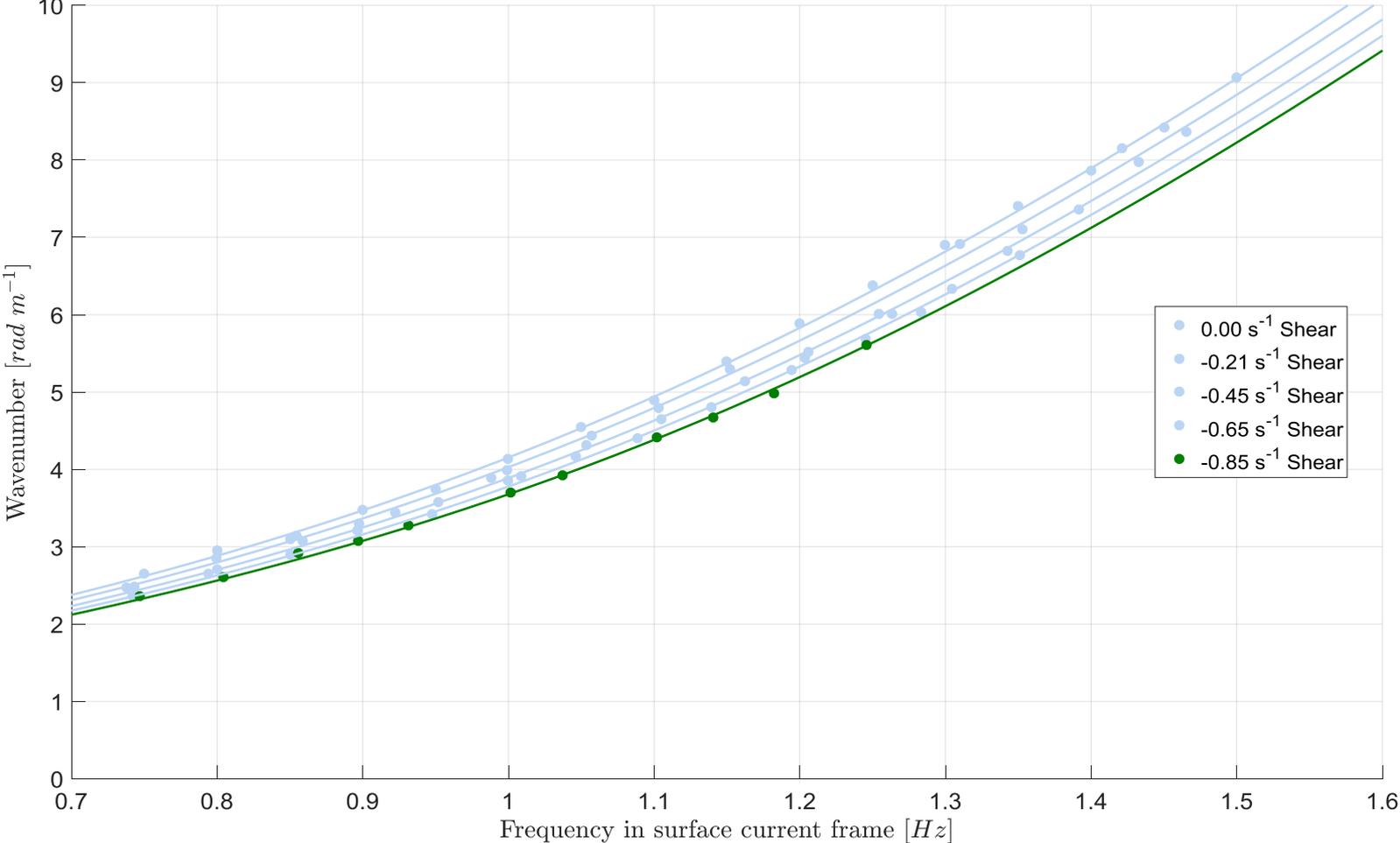
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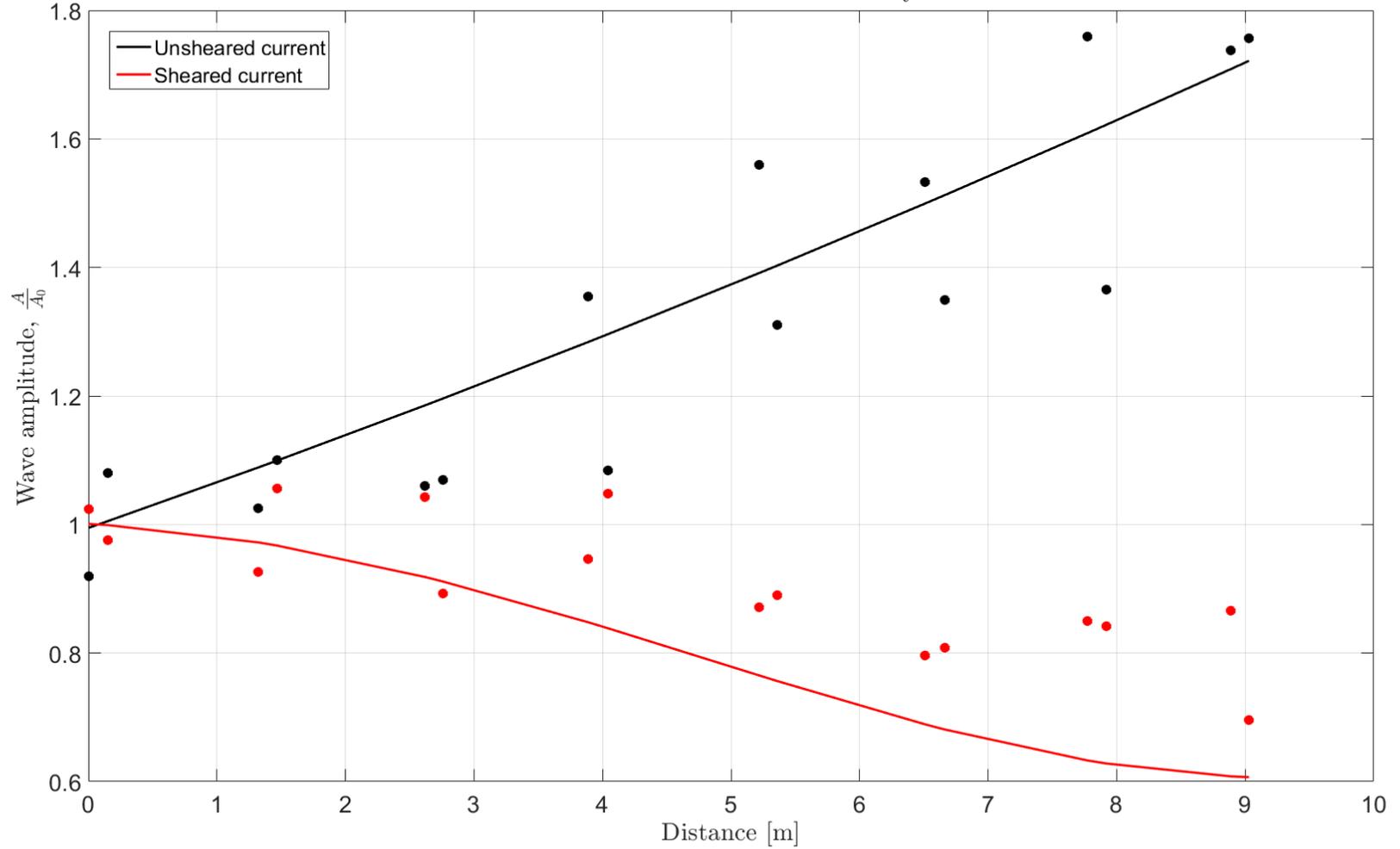
Dispersion relationship of waves on a vertically sheared current using measured wavelength data



Dispersion relationship of waves on a vertically sheared current using measured wavelength data



Effect of a sheared current on the stability of waves





Conclusions

- Numerical analysis shows that shear within current drastically alters the behaviour of waves
- Experiments have been completed to test this theory
- Results will be used to aid in the placement of marine energy devices



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