$\gg$ $N \to \infty$ vezanih oscilatora

- x_n = ravnotežni položaj n-te mase
- $\Delta x = x_{n+1} - x_n$ konstantni
- $x_n + \xi_n$ = položaj n-te mase pa je ξ_n pomak iz ravnoteže
- $N \to \infty$ tada $x_n \to x$, $\xi_n \equiv \xi(x_n) \to \xi(x)$
- Tada je sila na $(n = x/\Delta x)$-tu masu

$$
\begin{aligned}
m\ddot{\xi}_n &= k\xi_{n-1} - 2k\xi_n + k\xi_{n+1} \\
m\ddot{\xi}(x_n) &= k\xi(x_n - \Delta x) + 2k\xi(x_n) + k\xi(x_n + \Delta x) \\
m\ddot{\xi}(x) &= k\xi(x - \Delta x) + 2k\xi(x) + k\xi(x + \Delta x).
\end{aligned}
$$

$$
\begin{aligned}
m\frac{d^2\xi(x)}{dt^2} &= k\left[\Big(\xi(x+\Delta x) - \xi(x)\Big) - \Big(\xi(x) - \xi(x - \Delta x)\Big)\right] \\
\frac{m}{\Delta x}\frac{d^2\xi(x)}{dt^2} &= k\Delta x\left(\frac{\frac{\xi(x+\Delta x)-\xi(x)}{\Delta x} - \frac{\xi(x)-\xi(x-\Delta x)}{\Delta x}}{\Delta x}\right).
\end{aligned}
$$

$\gg N \to \infty$ vezanih oscilatora

$$\frac{m}{\Delta x}\frac{d^2\xi(x)}{dt^2} = k\Delta x\left(\frac{\frac{\xi(x+\Delta x)-\xi(x)}{\Delta x} - \frac{\xi(x)-\xi(x-\Delta x)}{\Delta x}}{\Delta x}\right)$$

$$\frac{m}{\Delta x}\frac{d^2\xi(x)}{dt^2} = (k\Delta x)\frac{\xi'(x)-\xi'(x-\Delta x)}{\Delta x} = (k\Delta x)\xi''(x).$$

Youngov modul elastičnosti

$$E \equiv k\Delta x$$

$$\rho\frac{d^2\xi(x)}{dt^2} = E\xi''(x)$$

- Valna jednadžba

$$\boxed{\rho\frac{\partial^2\xi(x,t)}{\partial t^2} = E\frac{\partial^2\xi(x,t)}{\partial x^2}}$$

$$\boxed{k \equiv \omega\sqrt{\frac{\rho}{E}}}$$

$$[k] = [\omega]\sqrt{\frac{[\rho]}{[E]}} = \frac{1}{\mathrm{s}}\sqrt{\frac{\mathrm{kg/m}}{\mathrm{kg\,m/s^2}}} = \frac{1}{\mathrm{m}}$$