2. 11 Beispiel: Profil der horizontalen Orbitalgeschwindigkeit u

Gegeben: Wassertiefe d = 10m
Wellenhöhe H = 2m
Wellenperiode T = 6, 12, 18s

Gesucht: Horizontale Geschwindigkeitsverteilungen für die Wellenphasen des Berges und des Tales

Lösung: Formeln (08),(14),(15);(02)+(17) bzw. Diagramm 03.10

Bestimmung der Wellenlängen:

T [s]	f [Hz]	c [m/s]	L [m]
6	0,167	8,17	49
12	0,083	9,5	114
18	0,056	9,78	176

Sohlgeschwindigkeiten:

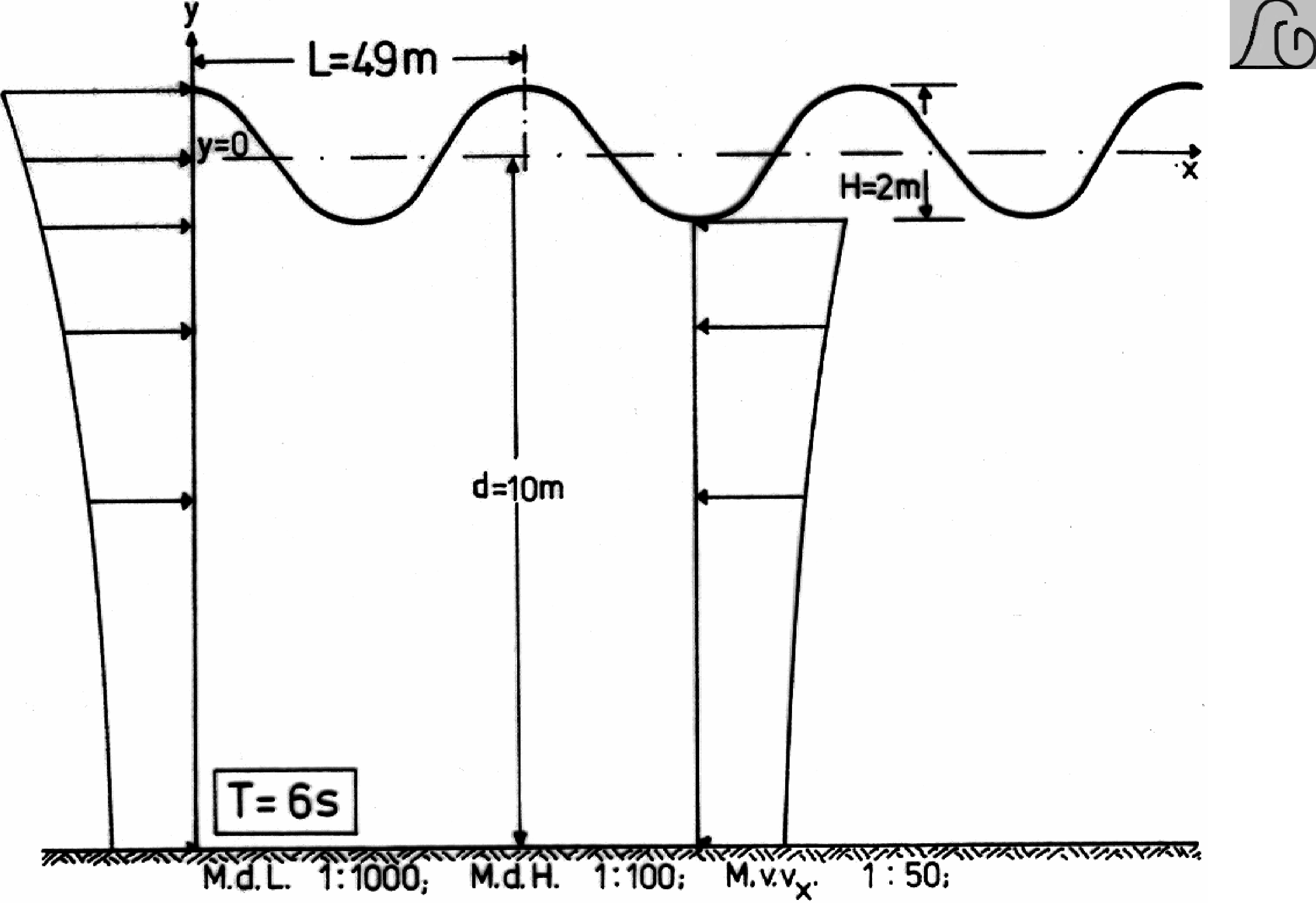
$$u_S = \pm \frac{H \cdot \pi}{T} \cdot \frac{1}{\sinh\left(\frac{2 \cdot \pi}{L} \cdot d\right)}$$

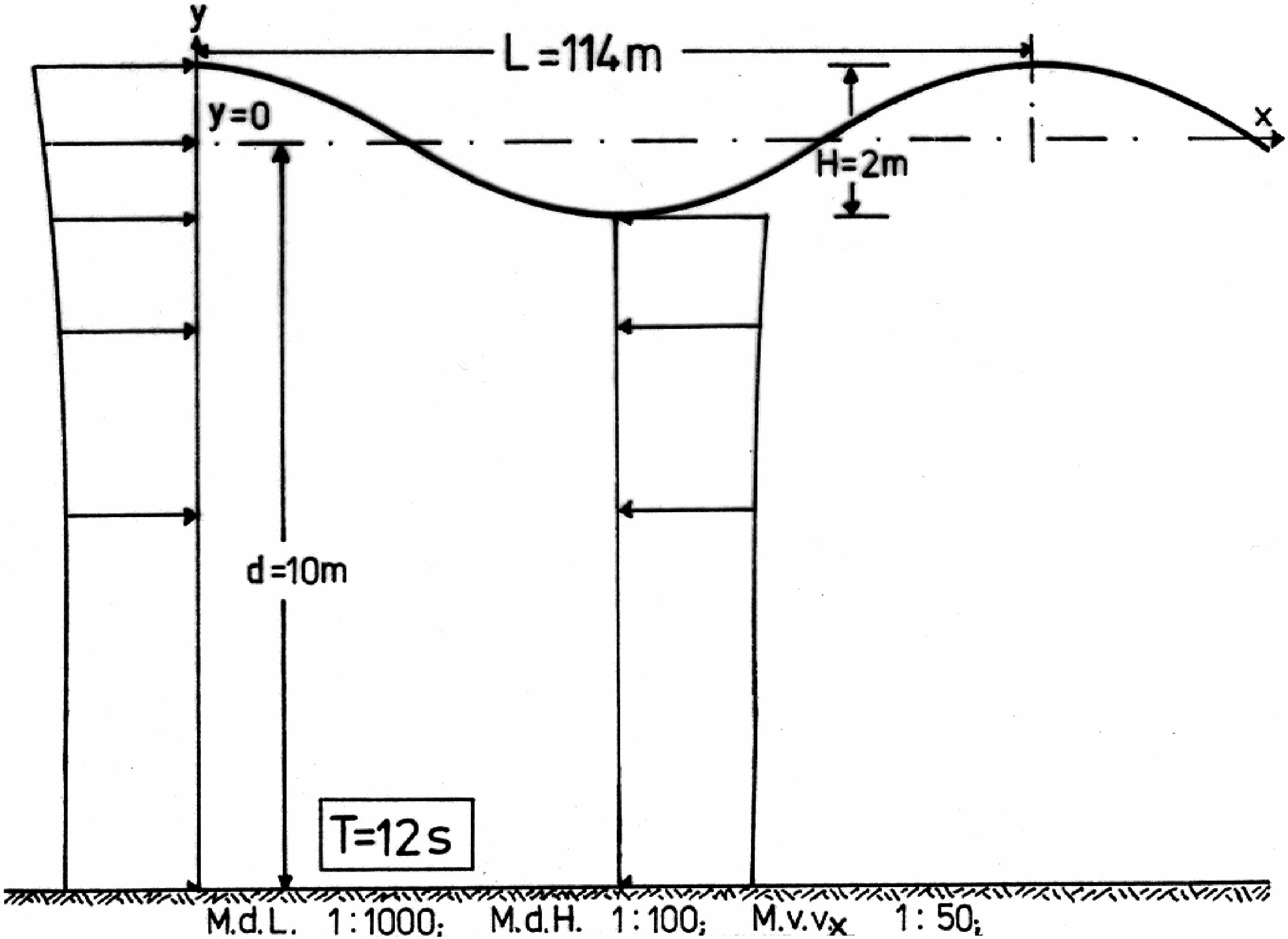
T	L	sinh2πd/L	u_s
[s]	[m]		[m/s]
6	49	1,6632	±0,629
12	114	0,5793	±0,905
18	176	0,3646	±0,957

Geschwindigkeiten u(y):

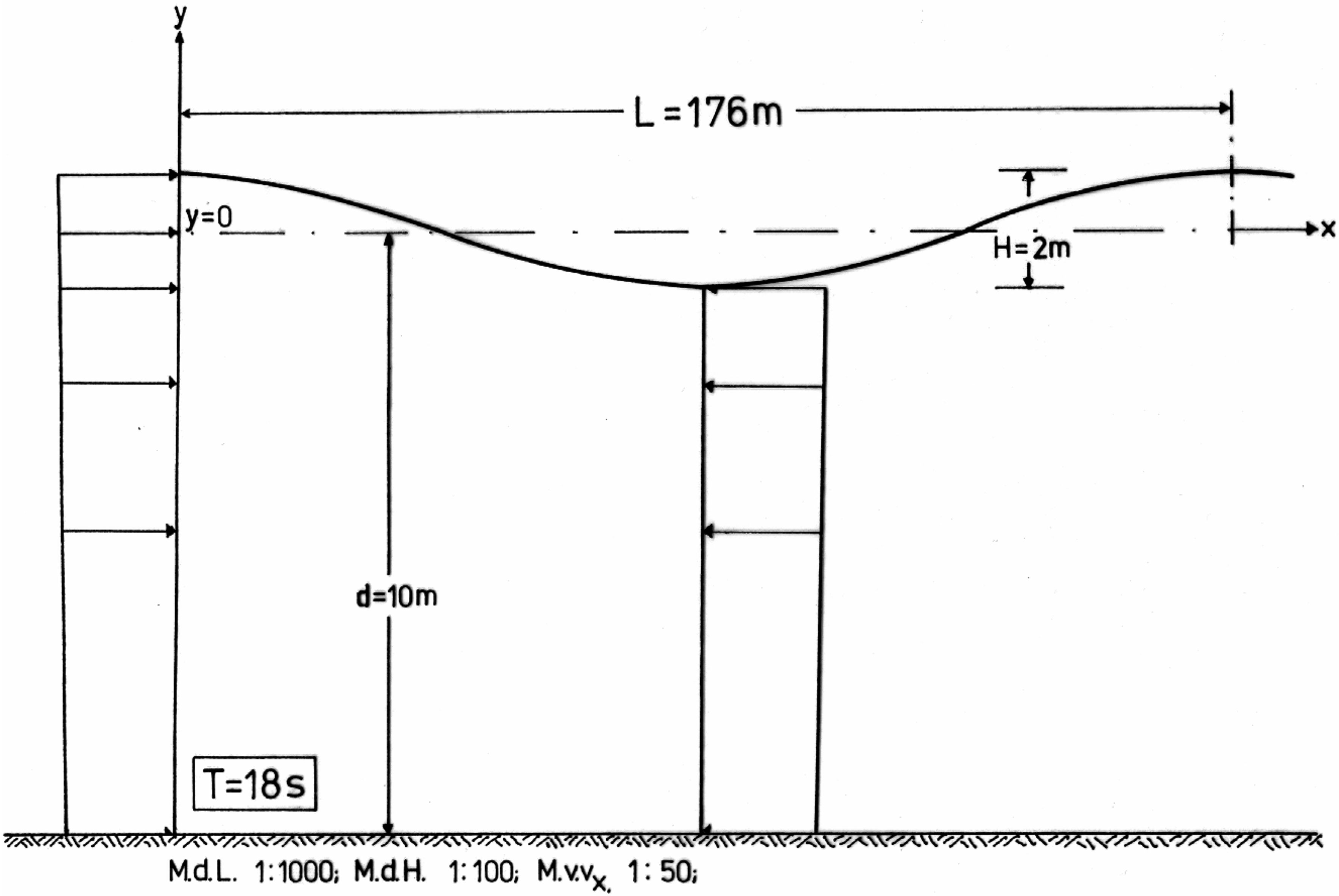
$$u(y) = \pm u_s \cdot \cosh\left(\frac{2 \cdot \pi}{L} \cdot (y + d)\right)$$

	T = 6s	T = 12s	T = 18s
y[m]	u(y)	u(y)	u(y)
1	1,37	1,08	1,03
0	1,22	1,05	1,02
-1	1,09	1,02	1,01
-2,5	0,94	0,98	0,99
-7,5	0,76	0,94	0,97
-10	0,629	0,905	0,975


y
L=49m
y=0
x
H=2m
d=10m
T= 6s
M.d.L. 1:1000; M.d.H. 1:100; M.v.v_x. 1 : 50;

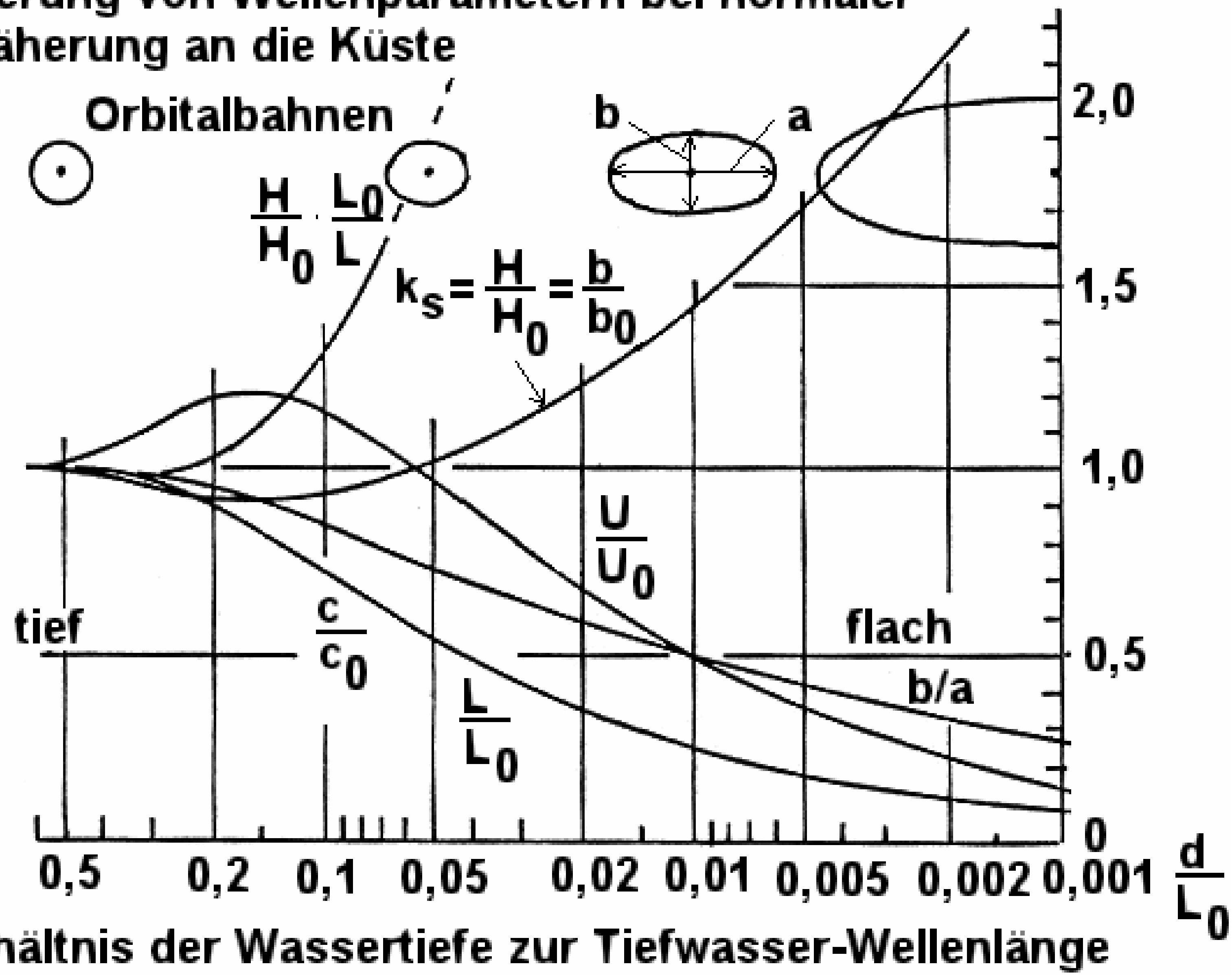


y
L = 114 m
y = 0
x
H = 2m
d = 10m
T = 12 s
M.d.L. 1:1000; M.d.H. 1:100; M.v.vx 1:50;



y
L = 176m
y=0
x
H=2m
d=10m
T=18s
M.d.L. 1:1000; M.d.H. 1:100; M.v.vx. 1: 50;

Änderung von Wellenparametern bei normaler Annäherung an die Küste



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2. 10. Formelsammlung

Wellenparameter \ relative Wassertiefe	Flachwasser $\frac{d}{L} < \frac{1}{25}$	Übergangsgebiet $\frac{1}{25} < \frac{d}{L} < \frac{1}{2}$	Tiefwasser $\frac{d}{L} > \frac{1}{2}$
1. Wellenprofil	$\eta = \frac{H}{2} \cos\left[\frac{2\pi x}{L} - \frac{2\pi t}{T}\right] = \frac{H}{2} \cos\theta = \frac{H}{2}\cos\left[k \cdot x - \omega \cdot t\right]$		
2. Wellenfortschritt = Phasengeschwindigkeit	$C = \frac{L}{T} = \sqrt{gd}$	$C = \frac{L}{T} = \frac{gT}{2\pi} \tanh\left(\frac{2\pi d}{L}\right) = \sqrt{\frac{gL}{2\pi} \tanh\left(\frac{2\pi d}{L}\right)}$	$C = C_0 = \frac{L}{T} = \frac{gT}{2\pi} = \sqrt{\frac{gL}{2\pi}}$ **= 1,56 T**
3. Wellenlänge	$L = T\sqrt{gd} = CT$	$L = \frac{gT^2}{2\pi} \tanh\left(\frac{2\pi d}{L}\right)$	$L = L_0 = \frac{gT^2}{2\pi} = C_0 T$ **= 1,56 T²**
4. Gruppengeschwindigkeit	$C_g = C = \sqrt{gd}$	$C_g = nC = \frac{1}{2}\left[1 + \frac{4\pi d/L}{\sinh(4\pi d/L)}\right] \cdot C$	$C_g = \frac{1}{2} C = \frac{gT}{4\pi}$
5. Teilchengeschwindigkeit horizontal	$u = \frac{H}{2}\sqrt{\frac{g}{d}} \cos\theta$	$u = \frac{H}{2} \frac{gT}{L} \frac{\cosh[2\pi(y+d)/L]}{\cosh(2\pi d/L)} \cos\theta$	$u = \frac{\pi H}{T} e^{\frac{2\pi y}{L}} \cos\theta$
vertikal	$v = \frac{H\pi}{T}\left(1 + \frac{y}{d}\right) \sin\theta$	$v = \frac{H}{2} \frac{gT}{L} \frac{\sinh[2\pi(y+d)/L]}{\cosh(2\pi d/L)} \sin\theta$	$v = \frac{\pi H}{T} e^{\frac{2\pi y}{L}} \sin\theta$
6. Teilchenbeschleunigung horizontal	$a_x = \frac{H\pi}{T}\sqrt{\frac{g}{d}} \sin\theta$	$a_x = \frac{g\pi H}{L} \frac{\cosh[2\pi(y+d)/L]}{\cosh(2\pi d/L)} \sin\theta$	$a_x = 2H\left(\frac{\pi}{T}\right)^2 e^{\frac{2\pi y}{L}} \sin\theta$
vertikal	$a_y = -2H\left(\frac{\pi}{T}\right)^2\left(1 + \frac{y}{d}\right) \cos\theta$	$a_z = -\frac{g\pi H}{L} \frac{\sinh[2\pi(y+d)/L]}{\cosh(2\pi d/L)} \cos\theta$	$a_z = -2H\left(\frac{\pi}{T}\right)^2 e^{\frac{2\pi y}{L}} \cos\theta$
7. Teilchenverschiebung horizontal	$\xi = -\frac{HT}{4\pi}\sqrt{\frac{g}{d}} \sin\theta$	$\xi = -\frac{H}{2} \frac{\cosh[2\pi(y+d)/L]}{\sinh(2\pi d/L)} \sin\theta$	$\xi = -\frac{H}{2} e^{\frac{2\pi y}{L}} \sin\theta$
vertikal	$\zeta = \frac{H}{2}\left(1 + \frac{y}{d}\right) \cos\theta$	$\zeta = \frac{H}{2} \frac{\sinh[2\pi(y+d)/L]}{\sinh(2\pi d/L)} \cos\theta$	$\zeta = \frac{H}{2} e^{\frac{2\pi y}{L}} \cos\theta$
8. Unterwasserdruck	$p = \rho g(\eta - y)$	$p = \rho g \eta \frac{\cosh[2\pi(y+d)/L]}{\cosh(2\pi d/L)} - \rho g y$	$p = \rho g \eta e^{\frac{2\pi y}{L}} - \rho g y$