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pocket references Pile Driving Formula
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Commonly used dynamic pile driving formulas

Formula Name	Equation	Year	Recommended Safety factor
Eytelwein (Dutch)	$R_u = \dfrac{e_h \cdot E_h}{s \cdot \left(1 + \dfrac{w}{W}\right)}$ (Drop hammers)	1820	$SF = 6$
	$R_u = \dfrac{e_h \cdot E_h}{s + \left(0.1 + \dfrac{w}{W}\right)}$ (Steam hammers)		
Weisbach	$R_u = -\left(\dfrac{s.A.E}{L}\right) + \sqrt{\dfrac{2 \cdot e_h \cdot E_h \cdot A \cdot E}{L} + \left(\dfrac{s \cdot A \cdot E}{L}\right)^2}$	1850	
Redtenbacher	$R_u = \dfrac{A.E}{L} \cdot \left(-s + \sqrt{s^2 + e_h \cdot E_h \cdot \dfrac{W}{W+w} \cdot \dfrac{2 \cdot L}{A \cdot E}}\right)$	1859	$SF = 3$
Engineering News-Record (ENR)	$R_u = \dfrac{e_h \cdot E_h}{s + z}$	1888	$SF = 6$
Navy-McKay	$R_u = \dfrac{e_h \cdot E_h}{s \cdot \left(1 + 0.3 \cdot \dfrac{w}{W}\right)}$		
Gates	$R_u = 27 \cdot \sqrt{e_h \cdot E_h} \cdot (1 - log(s))$ $e_h = 0.75$ (for drop hammers) $e_h = 0.85$ (for all other hammers) $R_u(kips)$ $s(in)$ $E_h(ft - kips)$	1957	$SF = 3$
Rankine	$R_u = \dfrac{2 \cdot A.E \cdot s}{L} \cdot \left(\sqrt{1 + \dfrac{e_h \cdot E_h \cdot L}{s^2 \cdot E \cdot A}} - 1\right)$		
Janbu	$R_u = \dfrac{e_h \cdot E_h}{K_u \cdot s}$ $K_u = C_d \cdot \left(1 + \sqrt{1 + \dfrac{\lambda}{C_d}}\right)$ $C_d = 0.75 + 0.15 \cdot \dfrac{w}{W}$ $\lambda = \dfrac{e_h \cdot E_h \cdot L}{A \cdot E \cdot s^2}$	1951	$SF = 3 - 6$
Pacific Coast Uniform Building Code (PCUBC)	$R_u = \dfrac{e_h \cdot E_h \cdot \dfrac{W + K \cdot w}{W + w}}{s + \dfrac{R_u \cdot L}{A \cdot E}}$ $K = 0.25$ (for steel piles) $K = 0.10$ (for all other piles)		$SF = 4$
Hilley	$R_u = \dfrac{e_h \cdot E_h}{s + 0.5 \cdot (C_1 + C_2 + C_3)} \cdot \dfrac{W + n^2 \cdot w}{W + w}$		$SF = 3$

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Gow	$R_u = \dfrac{e_h \cdot E_h}{s + z \cdot \dfrac{w}{W}}$		
Danish	$R_u = \dfrac{e_h \cdot E_h}{s + \sqrt{\dfrac{e_h \cdot E_h \cdot L}{2 \cdot A \cdot E}}}$	1967	$SF = 3 - 6$
Rabe	$R_u = \dfrac{e_h \cdot E_h}{s + C} \cdot \dfrac{w}{w + \dfrac{W}{2}} \cdot B$	1946	$SF = 2$
Modified (ENR*)	$R_u = \dfrac{e_h \cdot E_h}{s + z} \cdot \dfrac{W + n^2 \cdot w}{W + w}$	1965	$SF = 6$
Canadian National Building Code	$R_u = \dfrac{e_h \cdot E_h \cdot \dfrac{W + n^2 \cdot (0.5 \cdot w)}{W + w}}{s + \dfrac{R_u}{2 \cdot A} \cdot \left(\dfrac{L}{E} + 0.0001\right)}$		$SF = 3$

There are several formulas that are modifications of the ENR formula and are known as Modified ENR. The Modified ENR presented here was proposed by the Michigan State Highway Commission in 1965. Note: To be consistent, the net hammer energy is given in all equations as e_{hH} even though many of the formulas were developed for drop hammers where the hammer energy is given by W_h. No units are given for any terms (except for empirical formulas) so that any consistent set of units can be used.

A = cross-sectional area of pile.
A' = cross-sectional area of cushion block.
B = static supplement factor in Rabe's formula (10) for clarification).
C = temporary compression loss in the cap, pile, and soil; used in Rabe's formula (see (JO) for clarification).
$C_1 + C_2 + C_3$ = coefficients for Hiley equation.
e_h = efficiency of striking hammer (<.1.0).
E = Young's modulus of elasticity of pile.
E' = Young's modulus of elasticity of the cushion block.
E_h = manufacturer's hammer energy rating.
SF = factor of safety.
h = height of free fall of hammer.
k = a coefficient to account for elastic compression plus other losses in Redtenbacher's classical formula.
L = length of pile
L' = axial length of cushion block.
n = coefficient of restitution.
R_u = ultimate bearing capacity of pile in soil.
s = pile penetration for last blow, also Called "set".
w = weight of pile.
W = weight of hammer.
z = 0.1 for steam hammers; 1.0 for drop hammers.