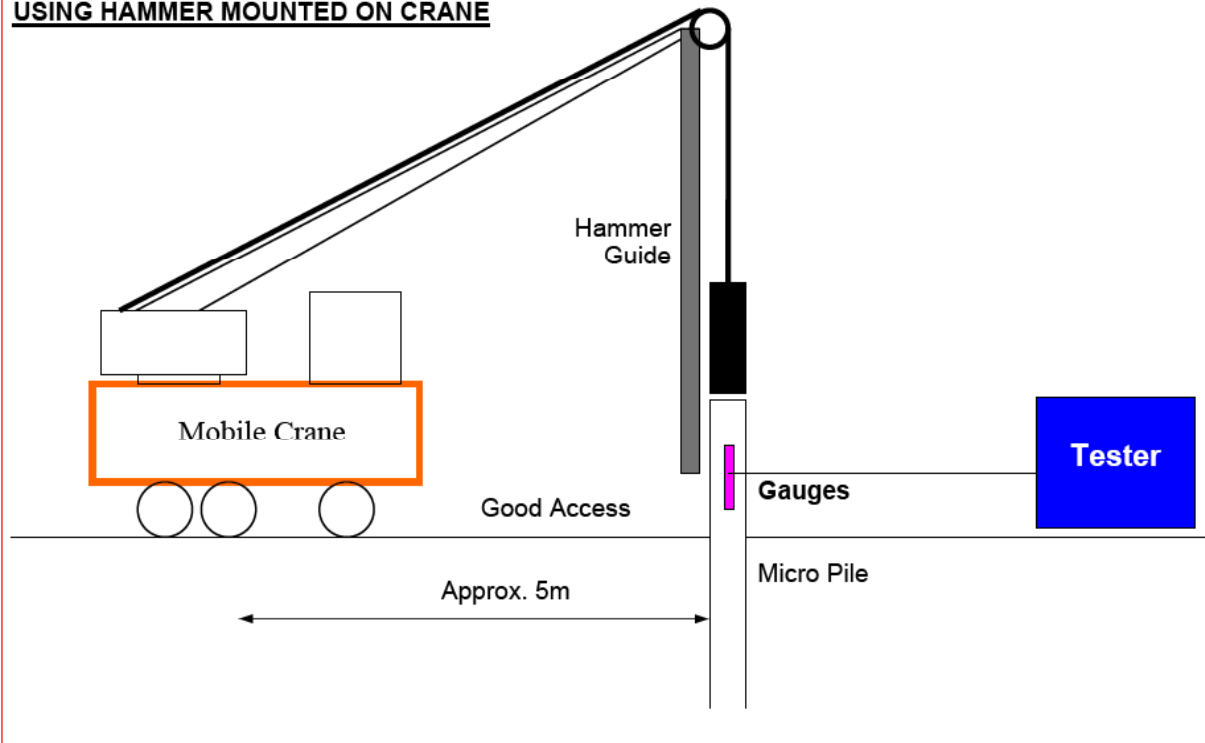


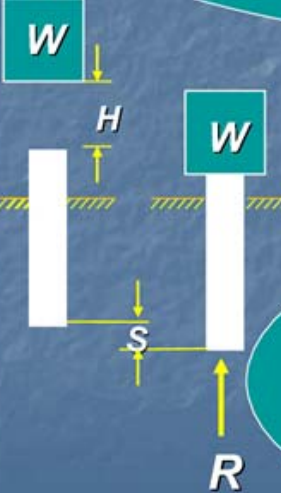
# DYNAMIC LOAD TEST

**HS-TESTING SETUP DIAGRAM**  
**USING HAMMER MOUNTED ON CRANE**





# DYNAMIC LOAD TEST

## Pile Driving Formulae: Dead End or are Still Useful?



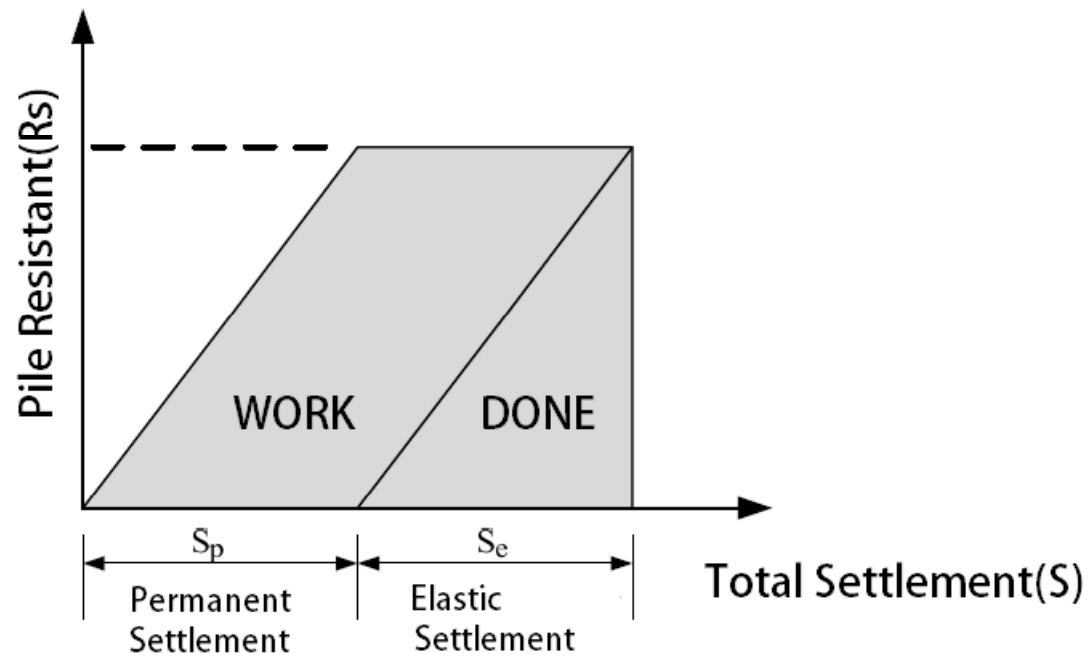
The diagram illustrates the pile driving process. A hammer of weight  $W$  is shown falling from a height  $H$  above the pile. The pile is driven into the soil to a depth  $S$ . The soil resistance is denoted by  $R$ .



$W H = R s$   
Hammer Energy = Work of Soil Resistance

$R = \frac{W H}{S} \xrightarrow[\text{FORMULA}]{\text{ENR}} R = \frac{W H}{S + C}$

# DYNAMIC LOAD TEST



CONCEPT OF PILE DRIVING FORMULA

# DYNAMIC LOAD TEST

## Common used for Pile driving formular

**1 MODIFIER ENR.  $P_u = e_h * E_h * (W_r + n^2 * W_p) / ((S + C) * (W_r + W_p))$**

**2 JANBU  $P_u = e_h * E_h / (k_u * S)$**

**3 DANISH  $P_u = e_h * E_h / (S + c_1)$**

**4 GATES  $P_u = 40 * \text{LOG}(1/4 * S) * \text{SQRT}(e_h * E_h)$**

$P_u$  = ultimate pile capacity (ton)

$e_h$  = efficiency of drop hammer  
drop hammer (rope&friction) ,  $e_h=0.75$

$E_h$  = Apply energy of drop hammer ,  $E_h=W_r * h$

$W_r$  = Ram weight(ton)

$h$  = Free fall drop height (m.)

$W_p$  = Weight of pile(ton)

$n$  = coefficient of restitution between ram and pile cap  
For wood cap,  $n=0.25$

$S$  = Average settlement per blow(m.)

$C$  = Coefficient of energy loss = 0.00254 m.

$c_1$  =  $\text{SQRT}(e_h * E_h * L / (2 * A * E))$

$L$  = Pile length(m.)

$A$  = Pile cross section area(m<sup>2</sup>)

$E$  = modulus of elasticity of pile (ton/m<sup>2</sup>)

$cd$  =  $0.75 + 0.15 * W_r / W_p$

$y$  =  $e_h * E_h * L / (A * E * S^2)$

$k_u$  =  $cd(1 + \text{SQRT}(1 + y/cd))$

# DYNAMIC LOAD TEST

## Performance of pile driving formulae

Delmag 30		Ultimate Pile Capacities according to different formulae, tons					
Ram 6,600 lb	Set 0.84 in	Empirical		Mechanistic			
Pile Type	Pile Length	ENR	Gates	WSDOT	Janbu	Hiley	Pacific Coast
12" PC/PS	80'	420	381	254	153	127	112
	40'				231	292	244
12" BP53	80'				189	253	176
	40'				231	292	244

*Hiley*

$$Q_u = \frac{Q_p \cdot h \cdot g}{s + 0.05(Q_{ult, pile} - Q_p) \cdot (Q_u - Q_p)}$$

*Kreuger (1 + 0.5s)*

$$Q_u = \frac{Q_p \cdot h \cdot g}{s + 0.5s} \cdot \frac{Q_u - 0.5s \cdot Q_p}{Q_u - Q_p}$$

*Janbu*  
k = 1.0

$$Q_u = \frac{2Q_p \cdot h \cdot g}{s + \sqrt{s^2 + 2Q_p \cdot h \cdot g} \cdot \frac{Q_u - 0.5s \cdot Q_p}{Q_u - Q_p}}$$

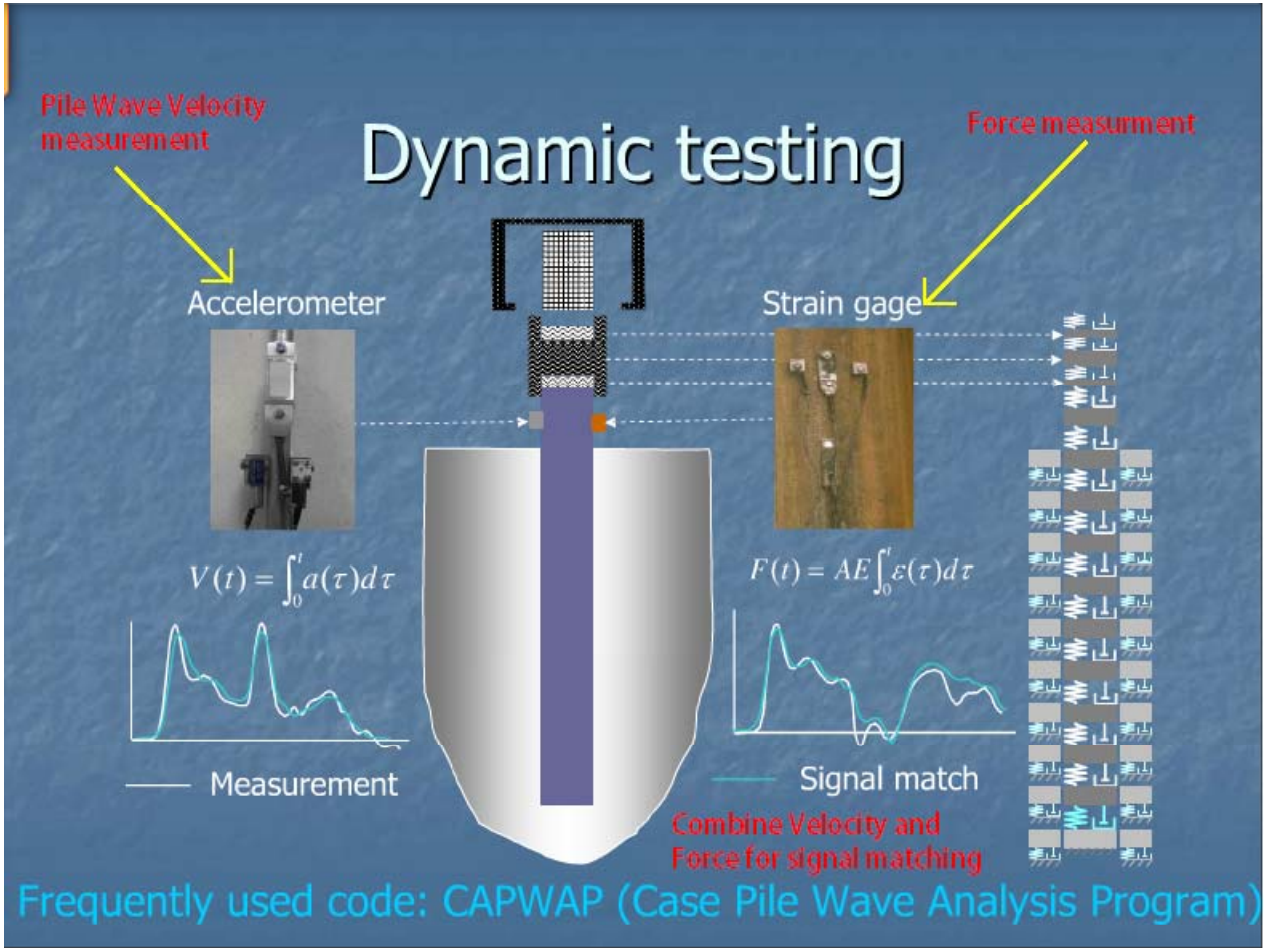
*Load distribution factor (s = 1.0)*

$$Q_{pile} = \left( \frac{Q_p \cdot h \cdot g}{E_p \cdot A_p} \right) \cdot \text{Load distribution factor (s = 1.0)}$$

Range: 112 tons to 420 tons

Traditional FS	
ENR	6.0
Gates	3.5
WSDOT	3.0
Hiley	3.0
Janbu	2.8
Pacific Coast	4.0

# DYNAMIC LOAD TEST



# DYNAMIC LOAD TEST

REAL PILE (STATIC LOAD TEST)	ANALYTICAL METHOD (REAL TIME RESULTS ON SITE)			POST PROCESSING
	CASE METHOD	IMPEDANCE METHOD	TNO METHOD	SIGNAL MATCHING
<p style="text-align: center;"><math>R_{TL} = R_{sta} = T_{sta} + \sum(S_{sta})</math></p>	<p style="text-align: center;">From strain gauge <math>R_{TL} = R_{sta} + R_{dyn}</math></p> <p style="text-align: center;"><math>R_{dyn} = J \frac{Mc}{L} V_{toe}</math></p> <p style="font-size: small;">where J is the CASE damping constant and V<sub>toe</sub> is the velocity at the toe of the pile. The velocity at the toe of the pile can be estimated from PDA measurements of force and velocity as:</p> $V_{toe} = V_{T1} + \frac{F_{T1} - R_{TL}}{Mc} \cdot L$	<p style="text-align: center;"><math>R_{TL} = R_{sta} + R_{dyn}</math></p>	<p style="text-align: center;"><math>R_{TL} = R_{sta} + R_{dyn}</math></p>	<p style="text-align: center;"><math>R_{TL} = R_{sta} + R_{dyn}</math></p> <p style="text-align: center;">CAPWAP OR SIMBAT</p>

REMARK:  $T_{sta}$  = Toe Resistance(Static Force),  $S_{sta}$  = Skin Resistance(Static Force),  $R_{sta} = T_{sta} + S_{sta}$   
 $T_{dyn}$  = Toe Resistance(Dynamic Force),  $S_{dyn}$  = Skin Resistance(Dynamic Force),  $R_{dyn} = T_{dyn} + S_{dyn}$

## SIMULATION OF PILE LOAD TEST BY WAVE MECHANICS THEORY



## DYNAMIC LOAD TEST

### Safety factors practice

- DYNAMIC FORMULA, FS = 3.0 to 3.5
- WAVE EQUATION, FS = 2.5
- DYNAMIC TESTING, FS = 2.25
- STATIC TESTING, FS = 1.8 TO 2.0



# DYNAMIC LOAD TEST

## PDI Frequently Asked Questions

### 1. Time delay from initial drive to restrrike

<b>Soil Type</b>	<b>Time Delay Until Restrike</b>
Cleans Sands	1 Day
Silty Sands	2 Days
Sandy Silts	3-5 Days
Silts and Clays	7-14 Days*
Shales	7 Days

\* - Longer times sometimes required. Specifying too short of a restrrike time for friction piles in fine grained soils may result in pile length overruns.

### 2. Minimum test requirement

2.1 At least 5% for initial test

2.2 At least 1% for restrrike test

*(Alberta Transportation, Edm, Alb, Canada)*