IMPACT LOAD ANALOGY IN PILE DRIVING ANALYSIS

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ABSTRACT: The dynamic pile formula[1] is the most common formula adopted by foundation engineers to predict the pile bearing capacity for driven piles. This formula is widely accepted for centuries even though its reliability and accuracy has not been determined[2]. Another new theory is proposed as an alternative to conventional dynamic pile formula to predict the pile bearing capacity during pile driving.

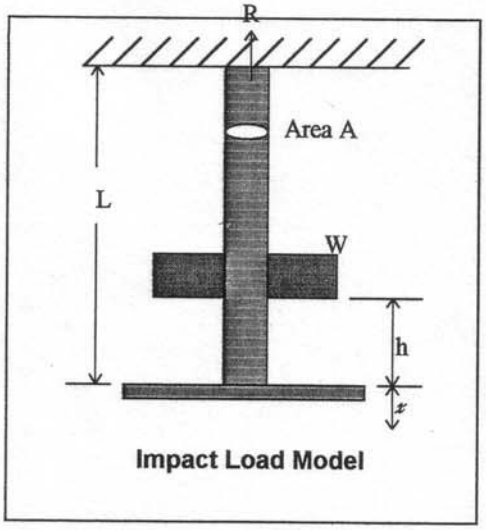
INTRODUCTION

In the piled foundation industry, the most important results of interest to the foundation engineers are the load bearing capacities of the piles. The most widely accepted formula to determine the pile bearing capacity for driven piles is the dynamic pile formula. This formula depends on the Mechanical Principle of Newton's 2nd Law of Motion. In this paper, another simple formula is proposed to predict the pile bearing capacity during pile driving. The proposed formula is derived from the analogy of an impact load applied to a pile based on the Impact Load in Direct Stress Analysis for a rod.

IMPACT LOAD ANALOGY

The model of the impact load applied to a rod simulates the pile driving behavior.

Impact Load Formula



Impact Load Model

Annotations:-

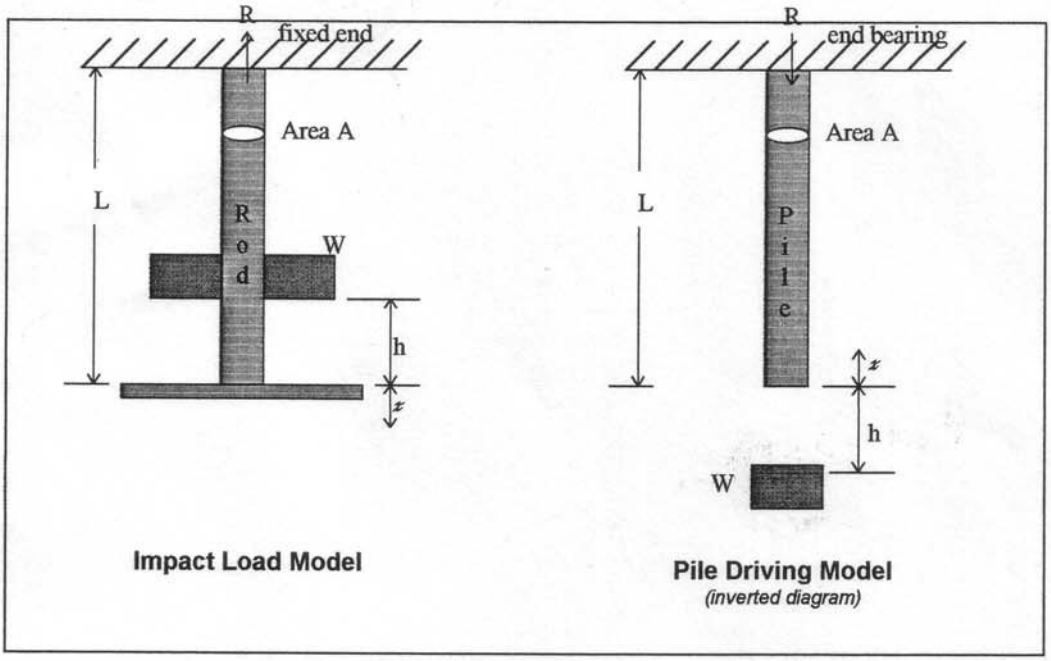
R	: impact (or resistance) load, tonnes
W	: weight of impact mass, tonnes
h	: stroke, m
x	: maximum displacement, m
L	: length of rod, m
A	: cross sectional area of rod, m^2
E	: Young's modulus of rod, tonnes/m^2

[1] Joseph E. Bowles (1988), "Foundation Analysis and Design", 4th edition, McGraw-Hill, pp. 791-796.
[2] Joseph E. Bowles (1988), "Foundation Analysis and Design", 4th edition, McGraw-Hill, pp. 801-803.

Impact load, $R = W\left[1+\sqrt{(1+2hAE/WL)}\right]$ Formula [A][3]

Formula [A] could be extracted from the Structural Analysis literature.

Analogy in pile driving



Annotations:-

R	: impact (or resistance) load = end bearing, tonnes
W	: weight of impact mass = weight of ram, tonnes
h	: stroke, m
x	: maximum displacement, m
L	: length of rod = length of pile, m
A	: cross sectional area of rod = cross sectional area of pile, m^2
E	: Young's modulus of rod = Young's modulus of pile, tonnes/m^2

In the pile driving analysis, 1 to 2% of ram weight is sufficient to drive the pile to achieve the desired bearing capacity, hence;

end bearing, $R \cong 100W$,

therefore Formula [A] becomes;

$$100W \Leftrightarrow W\left[1+\sqrt{(1+2hAE/WL)}\right]$$

[3] G.H Ryder (1969), "Strength of Materials", 3rd Edition, ELBS, pp. 9.

In the relationship above, the 2hAE/WL portion is the dominant factor in the equation, then;

$$100W \Leftrightarrow W\left[\sqrt{(2hAE/WL)}\right]$$

Substitute 100W as end bearing, R;

$$\therefore R = W\left[\sqrt{(2hAE/WL)}\right]$$

$$\Rightarrow R = \sqrt{2hAEW/L} \qquad \text{Formula [B]}$$

In conclusion Formula [B] is an analogy of impact load applied to a pile to predict the pile bearing capacity.