"A Study of the Maximum Transient Response of Simple Fully Yielding Structures."

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SYNOPSIS.

This thesis presents a report of an analytical investigation of the characteristic features of the transient response of fully yielding structures to a dynamic exciting force. The study was concerned with an estimation of the maximum possible peak-to-peak amplitude of simple idealised models subjected to pulses of a sinusoidal nature.

The study was mainly centred around the maximum response of the single degree of freedom elastoplastic system and the effect upon it of viscous damping and a transition region between the elastic and plastic states. The extension of the approach to the two degree of freedom elastoplastic system was also investigated.

The study was undertaken within the context of the earthquake engineering field. The investigation shows up certain basic characteristics of the transient response of fully yielding structures which appear to be common for widely varying types of exciting function. It also shows that the response of fully yielding structures to earthquake motions is probably a function of the characteristics of the largest pulses of an earthquake.

A brief review of the study of the inelastic response of structures in the earthquake engineering context is also presented.

NOTATION.

Symbols are defined where they first appear in the text. Below is a list of the more commonly occurring symbols, a brief description of their nature, and the page number locating the position in the text where they first appear.

N.B. In some cases the same symbols are used to describe the corresponding variables in the single degree of freedom system and the two degree of freedom system although the precise definition changes slightly. Two page numbers are given in these instances, the abbreviation 'SD' indicating the location of the definition within the context of the single degree of freedom system and '2D' indicating the location of the definition with respect to the two degree of freedom system.

Symbol	Description	Page
c	coefficient of viscous damping	50
c_1, c_2	seismic coefficient distribution factors	105
g	gravitational acceleration	
k	elastic stiffness	46
k_1, k_2	stiffness of individual spring elements	53 (SD)
		58 (2D)
m	mass	45
m_1, m_2	mass of individual mass elements	58
n	viscous damping ratio	50

p	natural undamped frequency	47
p_d	natural damped frequency	50
q_n	design viscous reduction factor	121
t	time variable measured from beginning of swing	45
t_1	time variable measured from transition from elastic to plastic state	48
w	frequency of forcing function	45
w_1	fundamental frequency	59
w_2	second natural frequency	63
x	displacement variable	46
x_1, x_2	displacement variables	61
A	base acceleration amplitude	45
C_b	base shear coefficient	59
C_U	base shear coefficient	47
C_{UO}	design undamped base shear coefficient	122
ΔE	energy input	96 (SD) 107 (2D)
F_U	Ultimate yield strength	53
F_Y	yield value	46
F_{YO}	partial yield value	53
F_{Y1}, F_{Y2}	yield value of individual friction elements	53 (SD) 58 (2D)
P	force amplitude	45
T	natural period	87
T_P	pulse period	87
V	Velocity at transition from elastic to plastic state	48

V_G	amplitude of ground velocity	91
X_E	maximum elastic deflection	46
X_{E1}, X_{E2}	maximum elastic deflection	59
X_G	amplitude of ground displacement	91
X_R	response amplitude	49
X_{1R}, X_{2R}	response amplitude	58
X_{TM}	maximum transient amplitude	41
α	force ratio	47 (SD)
		59 (2D)
β	frequency ratio	47 (SD)
		59 (2D)
γ	stiffness ratio	56
λ	stiffness ratio	59
μ	ductility factor associated with maximum possible transient amplitude	49
μ_o	μ of undamped system	75
μ_1, μ_2	μ for two story system	77
$\emptyset$	phase angle	45
σ	strength factor	59
η	mass ratio	59
Υ	transition factor	55
φ_1	fundamental frequency factor	59
φ_2	second natural frequency factor	63

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