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THE STRUCTURAL BEHAVIOUR OF LOW-RISE RESIDENTIAL BUILDING DUE TO WIND AND SEISMIC LOADS

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SESI PENGAJIAN: 2007/2008

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THE STRUCTURAL BEHAVIOUR OF LOW - RISE RESIDENTIAL BUILDING DUE TO WIND AND SEISMIC LOADS

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A thesis submitted in fulfillment of
the requirement for the award of the the
Degree of Master of Civil Engineering

Faculty of Civil and Environmental Engineering
Universiti Tun Hussein Onn Malaysia

JUNE 2008

I declare that this thesis entitled "The structural behavior of low rise residential building due to wind and seismic loads" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidate of any other degree"

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ABSTRAK

Angin dan seismic adalah ancaman semulajadi yang membawa kepada kemusnahan atau keruntuhan bangunan-bangunan rendah.. Kajian ini menerangkan kesan angin dan seismic kepada sifat penstrukturan bangunan-bangunan rendah dalam membangunkan reka bentuk bangunan kediaman dengan mengambil kira tahap ekonomi negara serta bahan-bahan tulen sedia ada. Perolehan data telah dibuat di suatu kawasan angin dan seismic bertekanan tinggi selama 20 tahun pusingan di Timor Leste. Kajian ini memfokus kepada analisis dua-dimensi rangka penahanan 3-petak 4-tingkat dalam kaedah lakaran reka bentuk. Beban angin ditentukan mengikut standard BS CP3 bab V bahagian 2 1972. Bebanan seismic pada bangunan diperolehi pada PGA rendah, sederhana dan tinggi selari dengan UBC 1997. Analisis ini dijalankan menggunakan perisian STAAD Pro 2004 untuk mengenal pasti elemen-elemen kritikal pada bangunan-bangunan berskala rendah di bawah riceh, anjakan dan moment berdasarkan bebanan angin dan seismic. Pengaplikasian beban angin dan seismic daripada bahagian tepi dan hadapan bangunan memberi pelbagai kesan kepada anjakan, riceh dan moment kepada struktur bangunan. Dengan memberi kepelbagaian sistem pengukuhan V dan X kepada struktur, pengurangan anjakan dengan riceh terendah dan nilai moment untuk komponen bangunan dapat dicapai. Hasil kajian menunjukkan struktur dengan sistem pengukuhan sesuai memperlihat pengurangan sebanyak 70% anjakan , 50% moment dan 33.5% riceh. Keadaan ini menerangkan bahawa sistem pengukuhan yang dicadangkan adalah kaedah yang efektif dalam meningkatkan kekukuhan dan kestabilan stuktur bangunan seterusnya mengurangkan kemungkinan berlaku keruntuhan bangunan.

Keywords: Bangunan rendah, STAAD Pro, Angin dan Seismic, sistem pengukuhan.

ABSTRACT

Buildings are subjected to natural hazards such as wind and seismic, and when subjected too, will have an effect on the overall behaviour of the structure. This study describes the effect of wind and seismic loads towards the structural behaviour of low rise residential building in Timur Leste. Various bracing system design were proposed to the building and analytical results were recorded and observed. Wind data velocity (V) was taken at 33 m/s in open country. The data was collected at location for wind and seismic on high intensities for a 20 year cycle. For the simplicity of illustrating the design, the study focuses on the analysis of a two and three dimensional three bay four-storey moment resisting frames on rigid foundation. Lateral wind load was determined in accordance to BS CP3 Chapter V part 2 1972 standard. Seismic deign load on building was obtained at Peak Ground Acceleration (PGA) for low, medium and high ground motion on building in accordance with UBS 1997. The analysis of the building was conducted using STAAD Pro 2004 to identify critical members and elements of the low rise building under shear, displacement and moments due to wind and seismic loading. In applying wind and seismic load from side and front of building, large values of displacement, shear and moment was observed at critical points of the structure. By providing bracing system types V and X to the structure, less displacement with lower shear and moment values for the building component was achieved. Result shows that for structures with suitable bracing system, an overall reduction of about 70% in displacement; 50% in moment and 33.5% in shear was observed. This implies that by applying the bracing system, the rigidity and stability of the structure has increased and the risk of collapse has substantially reduced.

Keywords: Low rise building, STAAD Pro, wind and seismic load, bracing system.

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SYMBOL

a	Times the acceleration
A_e	Effective frontal (strip) area considered for the structure at height z
B	Width of building normal to the oncoming wind
C	Drag force coefficient; and
C	General Factor that accounts for the specific
C_e	Combined height, exposure and gust factor coefficient
C_f	Force coefficient for the building
Cp	Pressure coefficient
Cq	Pressure coefficient for the structure under consideration
C_{dyn}	Dynamic response factor (total load/ mean load)
d_0	The lowest height of validity of $\bar{U}(z)$ in m
DL	Dead Load
E	Modulus elasticity
EL	Seismic Load
f_0	First mode natural frequency of vibration of a structure in the along wind direction in hertz.
f_c	$2\Omega \sin\phi$ = Coriolis parameter in 1/s
F_z	Along-wind equivalent static load on the structure at any height z corresponding to strip area A_e
g_R	Peak factor for resonant response (1 hour period)
h_i	Height of the i floor above the base

h_k - Denotes the internal boundary layer
H - Average roof height of structure above the ground
H - The height to caves is parapet
H_s - Height factor for the resonant response
I - An importance factor
I_h - Turbulence Intensity, 0btain from table 31 by setting z equal to h
k - The power that differs from one seismic code to another
K - Von Karman's constant $k \cong 0.4$
L - The greater horizontal dimension of a building
LL - Live Load
M - Moment
M - Mass of the building
N - Number of stories
P - Wind pressure
P - Mean wind load
P_o - Atmospheric pressure
P_Z - Wind pressure in N/m2 at height z (pz) obtained 0.6 (N/m^2)
P(z,t) - Peak externally applied wind load in which
$P_{\max}$ - 1 sec. Maximum pressure
$P_{\min}$ - 1 sec. Minimum pressure
q - Dynamic pressure of wind (stagnation pressure)
Qs - Wind stagnation pressure
R_W - Principal new factor
S - Size reduction factor given
S_a - Altitude and topography factor
S_b - Terrain and building factor
S_d - A direction factor used to ensure that when specific wind direction are used in the design calculations the risk of accidences is the same for direction.

S_p - Probability factor to allow the designer to select a risk other than the standard 2% per annum.

S_s - A seasonal factor to allow for non-permanent structures

S_1 - Topography factor

S_2 - Factor accounting for building height, element size and terrain category

S_3 - Probability factor used to vary the annual design risk. (Analysis S3=1.0)

S_4 - Direction factor defined as for BS 6399. In this analysis S4= 1.0

$\bar{U}(Z)$ - Mean velocity of the wind at height z above ground in m/s

V - Mean wind velocity at building heigt

V - Seismic base shear (Vertical component of force)

Vs - A site wind speed

x - Distance from the step in roughness

W - The lesser horizontal dimension a building

WL - Wind Load

W - Weigh of building

W_i - The weight of building

z - Height above ground in m

Z - Factor adjust for probability

z_0 - Roughness length in meter

$Z_{0,\max}$ - The larger of the upstream and down stream roughness

Ω - 0.726 10-4 = angular rotation velocity in rad/s

ϕ - Latitude of location in degree

ρ - Density by of air (1.225 kg/m3)

$1/2\rho V^2$ - Dynamic pressure-Static pressure at building height

FIGURE

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