EFFECT OF STAIRS ON SEISMIC PERFORMANCE OF REINFORCED CONCRETE BUILDINGS

By

Reem Nady Abo-Serie EL-Nady Helal

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
STRUCTURAL ENGINEERING

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Under the Supervision of

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Title of Thesis:

Effect of stairs on Seismic Performance of Reinforced Concrete Building

Key Words:
Staircase element, fundamental period, linear analysis, seismic force

Summary:
Staircase elements in buildings are usually designed for gravity loads only while their contribution in resisting seismic loads is neglected. However, stairs increase the overall stiffness of structures and may attract considerable seismic forces leading to their damage and failure and thus losing their important role in life loss prevention during and after earthquakes. This thesis studies and evaluates the influence of stairs in seismic performance of multi-story building structures according to Egyptian code of practice. Response spectrum and equivalent static load methods are used for the analysis. Buildings are modelled as a three dimensional finite element model using SAP2000 program. The building response behavior is considered linear elastic. The design parameters considered in this thesis includes stair location and orientation, slab structural system, building height.

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LIST OF ABBREVIATIONS

ECP	Egyptian Code for Calculating of Loads and Forces on Buildings
EQ	Equivalent Static Load Method
EQx	Equivalent Static Load Method-X Direction
EQy	Equivalent Static Load Method-Y Direction
RS	Response Spectrum method
RSx	Response Spectrum method - X Direction
RSy	Response Spectrum method - Y Direction

LIST OF SYMBOLS

a_g	The design ground acceleration for the reference return period;
DL	Dead load;
f_{cu}	Concrete compressive strength;
f_y	Steel yield strength;
Fi	Horizontal seismic force of floor;
g	Gravitational acceleration;
H	Total height of the structure;
h	Total height of the structure;
$I_{effective}$	Elements effective moment of inertia;
I_g	Elements gross moment of inertia;
I_p	Important factor for the non-structural elements;
LL	Live load;
R	Structure response modification factor;
m	meter;
R	Structure response modification factor;
S	Soil factor;
S_A	Design response spectrum;
S_d (T)	Horizontal deign response spectrum for seismic analysis;
Se	Earthquake loads;
t.m.	Ton.meter
T	Vibration period for a single degree of freedom system or fundamental period of the structure in second;
T_a	Fundamental period of the non-structural elements;
T_B , T_C	Limits of the constant branch of the response spectrum;
T_D	Determined value of the beginning constant displacement response range of spectrum;
W	Total Weight of the Structure;
Wi	Weight of floor;
Zi	Height of the floor above the base of the building;

ABSTRACT

Staircase elements in buildings are usually designed for gravity loads only while their contribution in resisting seismic loads is neglected. However, stairs increase the overall stiffness of structures and may attract considerable seismic forces leading to their damage and failure and thus losing their important role in life loss prevention during and after earthquakes. This thesis reviews and evaluates the influence of stairs in seismic performance of multi-story building structures according to Egyptian code of practice. Response spectrum and equivalent static load methods are used for the analysis. Buildings are modelled as a three dimensional finite element model using SAP2000 program. The building response behavior is considered linear elastic. The design parameters considered in this thesis includes stair location, slab system, building height.