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CYRUS A. MELICK

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STRESSES IN TALL BUILDINGS

AN INVESTIGATION OF THE STRESSES IN TALL STEEL BUILDINGS OF THE CAGE CONSTRUCTION TYPE WITH PORTAL BRACING

BY

CYRUS ALAN MELICK, D.C.E.

COLUMBUS, OHIO
1912

INTRODUCTION.

This investigation has been undertaken with a three-fold purpose in view, as follows:

First, to develop a practicable mathematical solution of the stresses in tall buildings with portal bracing for all types of loadings, and, by its application, to determine the principal errors which exist in present methods of design.

Second, to endeavor by experiment on an existing structure to find by actual measurement the distribution and amount of stresses and distortions due to wind pressures, the only loading which can be practically varied on such a structure.

Third, to give in a final chapter a full and definite resumé of all findings and suggestions for designers as derived therefrom, so as to make the results of the investigation of value to the practicing engineer or architect without wasting his time in perusal of the body of the investigation, a proceeding which would, it is believed, be a discouraging one for a man who has been too busy in practical work to follow up closely a mathematical discussion.

This investigation consists, then, of a series of mathematical demonstrations, followed by an extensive series of applications and comparisons, and, finally, what is believed to be some very valuable conclusions offered in the last chapter, with references to the chapters from which the conclusions are drawn in case more detailed information is desired. Results have been shown graphically as far as possible, in addition to giving the actual tabular values. It is believed the investigation will be equally of value to the practical as well as to the theoretical man.

The mathematical treatment is based on an entirely elastic structure with what is believed to be an entire freedom from erroneous or doubtful assumptions.

This study has been made possible through the generosity of the late Professor Stillman W. Robinson, who established at the Ohio State University the Stillman W. Robinson Fellowship in Engineering. The writer has, during the years 1909–11, endeavored to

carry out the purpose Professor Robinson had in view in establishing the fellowship and now takes great pleasure in presenting to the Ohio State University and, through this institution, to the engineering profession generally, the results of a careful and diligent study of the stresses in tall buildings.

Acknowledgments are made and the author's sincere thanks extended as follows:

To the Ohio State University for financing the investigation.

To the Robinson Fellowship Committee for interest shown and advice given.

To Professor C. T. Morris, professor of structural engineering, for the interest shown, and advice and suggestions given throughout the work.

To Mr. J. Warren Smith, Section Director of the U. S. Weather Bureau.

To Mr. Frank L. Packard, architect, and his engineer, Mr. E. F. Babbitt, for furnishing plans and data.

To Mr. A. L. Fisher, superintendent of the structure used for the experiments.

Many others have, by suggestions and minor aid, been of assistance, and thanks are hereby extended to them collectively.

CYRUS A. MELICK.

COLUMBUS, OHIO,
June, 1911.

TABLE OF CONTENTS.

NOTATION.

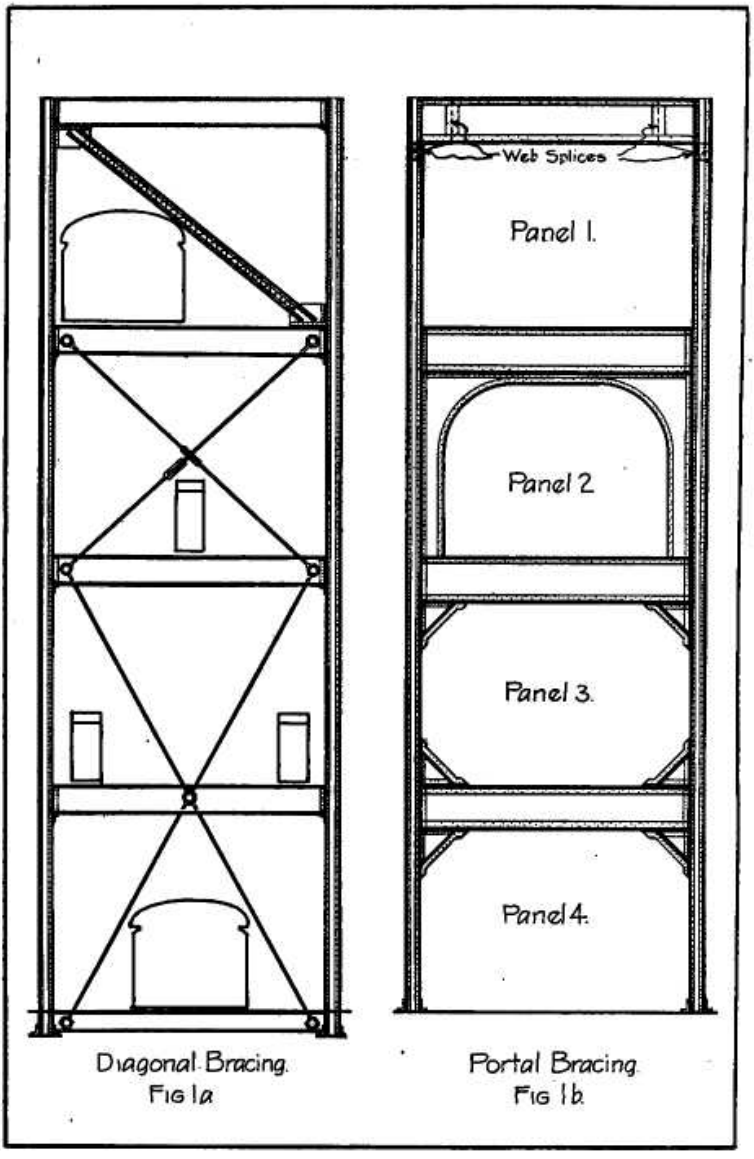
The following symbols are used throughout this investigation with the designations here given except in cases where there can be no confusion and in such cases a note is made of the exception.

Subscripts used in connection with the symbols below or any other symbols given later on always designate the floor in which the quantity occurs unless otherwise noted.

Exponents used in connection with the symbols below or any other symbols given later on always designate the member to which the symbol applies or the expression or equation in which it occurs unless otherwise noted. Thus I_3^A represents the moment of inertia of the third floor section of column A.

All the following quantities are in inch and pound units.

I = moment of inertia.
A = area of cross section.
E = modulus of elasticity.
b = distance center to center of columns.
c = story height measured between centers of gravity of girder flanges.
d = depth of floor girder, center to center of gravity of flanges.
V = axial compressive stress in a column.
H = axial compressive stress in a floqr girder.
S = horizontal shear across a column section.
M = bending moment at foot of a column section ($x = 0$).
s = axial unit stress.
s' = extreme fibre unit stress from bending only.
f = resultant extreme fibre unit stress.
r = minimum radius of gyration.
v = distance from neutral axis of column to the extreme fibre.
W = total load on any floor girder (considered as uniform).
w = floor load per lineal inch of girder.
P = concentrated load applied directly or indirectly to a column.
F = concentrated wind pressure for one story—considered as applied to the building at mid depth of the floor girders.



Diagonal Bracing.
Fig 1a

Portal Bracing.
Fig 1b