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Comparisons of Various By-Laws Covering Flat Slab Concrete Buildings, with Actual Tests

Codes Compared Give Fairly Similar Results Under Actual Conditions and When Reduced to a Common Basis—Tests Made on the Wm. Davies Building, Toronto

By W. W. PEARSE

City Architect and Superintendent of Building Toronto

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EDITOR CANADIAN ENGINEER:

You no doubt are aware that Toronto has no building code to govern the flat slab type of construction, and as a number of large buildings have been erected by this method, it was necessary for this department to give a ruling as to what American codes would be allowed. Up to the present time I have passed those of Chicago and Philadelphia, and structures have been designed by these two methods. Upon an examination of Table No. 1, it will be noted that there is really very little difference between the two by-laws when they are compared on a common basis.

I am handing you herewith copies of tests made on the reinforced concrete building of the William Davies Company, Limited, of Toronto, and as noted elsewhere, the structure is designed in what is commonly known as the two-way flat slab type of construction. I have endeavored to compare the codes of Chicago, Philadelphia and Pittsburgh, also the regulations proposed by the Joint Committee on Concrete and Reinforced Concrete, with the actual stresses which were measured by extensometers. From a first observation it would appear as if none of the codes gave results that would in any way compare with the actual tests, but if the actual conditions were taken into consideration, such as the tension in the concrete, I found that they all gave a very fair comparison with the actual test as far as we had sufficient readings to go by. The steel at the column cap agreed approximately and the concrete was within fair bounds. The centre part of the slab could not be compared very well, due to the fact that the concrete readings were not taken immediately above the steel readings and, therefore, the neutral axes of the sections could not be arrived at.

It is evident from the very nature of things that the comparisons must always vary considerably, due to the utter impossibility of being able to get two batches of concrete the same mix, etc.; therefore the modulus of elasticity will constantly vary at different sections. As pointed out in the discussion, no test was made to arrive at the modulus of elasticity of concrete in tension. It has been the common assumption that the concrete has the same modulus for either tension or compression, but Johnson's "Materials of Construction" gives a number of tests and he states that the ratio is 7:10. I have taken it as 8:10, taking as a basis for compression as 3,000,000 pounds, whereas the tests warrant anywhere from that figure to 3,500,000 pounds.

One test is not sufficient evidence on which to base any theory, but as I have a number of other tests on which I am working, the results of these may throw additional light on the subject.

Mr. T. D. Mylrea conducted the tests and Mr. W. A. McM. Cook, of the city architect's department, carefully checked over all my work.

Trusting the above may be of some interest to your readers, I am

Yours very truly,

W. W. PEARSE,

City Architect and Superintendent of Building.

The method of construction used in this building is the two-way flat slab, drop head, reinforced concrete system, briefly known as the "two-way system," and the following discussion will be so designated.

A comparison will now be made of the stresses found by the actual extensometer tests and those found by applying the different city by-laws.

The first by-law to be considered will be the Chicago Code.

Notation:

L = distance centre to centre of columns, in feet.
L_1 = distance edge to edge of heads of capitals, in ins.
w = total live and dead load per square foot = 142 + 82 = 224 lbs.
w_L = live load per square foot.
W = total panel load in lbs. = $w L^2$.
W_L = total live load on panel in lbs. = $w_L L^2$.
W^1 = W — load within area of column capital.
d = distance, in inches, from centre of gravity of centroid to centre of gravity of steel at the drop.
d_1 = distance, in inches, from centre of gravity of centroid to centre of gravity of steel at the centre of slab. "Centroid" is used in the sense of equivalent compressive area.
s = tensile stress per square inch in steel.
c = extreme fibre compression stress per square inch in concrete.
$-M$ = moment at edge of capital head.
$+M$ = moment at centre of span.