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Results of Test on Robert Simpson Building

Comparison Made With Flat Slab Codes—Simplicity of Construction, Economy in Story Heights, Unbroken Ceilings, Make Flat Slab Construction Popular

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At the time the tests referred to in this article were made, Professor Gillespie kindly consented to help the Architects' Department in conducting a test which would prove whether the building was strong enough to carry the loads for which it was designed, and it was also thought that the tests would give additional information to the department so that it might be in a position to draft an up-to-date by-law covering flat slab type of construction.

Due to the cracks around the column capital, it was necessary, as shown in Fig. 6, to break the panel into strips, finding the moment of inertia of each strip and then adding them together. This, of course, would only give at best a very rough approximation, and, therefore, in considering these tests, due consideration must be given to this. I might also direct attention to the stresses given on Fig. 3-4, where it will be noticed, in a great many cases, that when the load is removed entirely, there still seems to be a larger stress in the steel and concrete than what was given by the first load of 135 pounds. This is shown in tables of stresses under columns 1 and 4. One explanation for this is that concrete has not the elastic nature that steel has but is more plastic, and, therefore, when the load is applied to the concrete, the concrete in compression is crushed and does not spring back to its original position. Another reason, no doubt, is due to the fact that, when the second load of 270 pounds was applied, bad cracks developed around the column capital head, thereby weakening the resisting value of the concrete in tension, so that even when all the loads were removed the original dead load would cause considerable stress in the steel and concrete due to the damaged condition of the concrete, therefore, when the final extensometer readings are taken the set of the concrete will be read by the instrument.

The deep cracks around the column heads are due to the steel work being set too low below the top of concrete. It will be noted by referring to Fig. 3, Col. 23, that the average distance below the top of the concrete to the steel is about 3½ inches. It is evident, therefore, that as soon as there is any tensile stress in the steel that there must be considerable tensile stress in the outside fibres of the concrete, and as this is only good for about 350 pounds to the square inch it would soon crack. From this test it would seem to the writer that either Chicago or Philadelphia codes, or the Report of the Joint Committee would give very safe and satisfactory results.

Professor Gillespie was assisted by Mr. R. J. Fuller and Mr. T. D. Mylrea, who were in the employ of this department at the time the tests were made, and Mr. W. A. McM. Cook, of this department, assisted in compiling the results as given herewith.

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THE method of construction used in the Robt. Simpson Building, Toronto, is the four-way flat-slab drop-head reinforced concrete system known as "the four-way system."

Fig. 1 is a general plan of the building showing the area tested.

Figs. 2, 3 and 4 show the arrangement of the reinforcement, and the location of the points where the readings were taken and the stresses obtained.

The readings for a live load of 135 lbs. per square foot will be considered.

In comparing the stresses found by extensometer tests and those computed in accordance with the various building regulations the following notation will be used:—

L = distance c. to c. of column, in feet.
w = total live and dead load per square foot = 135 + 113 = 248 lbs.
W = total panel load in lbs. = wL^2.
s = tensile stress per square inch in steel.
c_t = extreme fibre tensile stress per sq. in. in concrete.
c = extreme fibre compressive stress per square inch in concrete.
I = moment of inertia.
Q_t = section modulus for side in tension.
Q_c = section modulus for side in compression.
E_s = modulus of elasticity of steel = 30,000,000.
E_c = modulus of elasticity of concrete in compression = 3,500,000.
E_t = modulus of elasticity of concrete in tension = 2,800,000 (assumed as $\frac{8}{10}E_c$ same as used for Wm. Davies Co. Building, Toronto).

Fig. 5 shows the strips into which the slab is considered to be divided for purposes of calculation.

Strip A at Edge of Capital

The stresses in strip A at the edge of the column capital will be considered first. The width of strip A will be taken as $\frac{L}{2}$, as assumed in the Chicago Code and Joint Committee Report.

In Fig. 6 the neutral axis, as obtained from deformations, has been plotted for readings Nos. 710, 713, 717, 601, 607 and 614, and its average position was found to be 9¼ ins. from the top of the slab, as indicated

In order to arrive at a rational method for determining the section moduli of the section, making due allowance for tension in the concrete, it was assumed that the tensile strength of concrete is 1/12th of its compressive strength (see "Materials of Construction," 4th edition, by J. B. Johnson, p. 604d) and thence was found the maximum deformation which could occur in the concrete without the formation of cracks.

The ultimate compressive strength of the concrete was found by test to be 3,900 pounds per square inch. Hence the ultimate tensile strength would be $\frac{3,900}{12}$ pounds per square inch = 325 pounds per square inch, and the corresponding deformation reading for live load, $325 \times \frac{40,000}{2,800,000} \times \frac{135}{248} = 2.5$ (see note at foot of Table 4), taking $E_t = \frac{8}{10}$, E_c = 2,800,000 for the concrete used.