to one, and for many floors the area to be covered with the stipulated floor load before a girder can receive its maximum stress is six or seven hundred square feet. Manifestly, the probability of an area of this size being *entirely* covered with the full floor load is very small. Even in the case of storage warehouses, where the probability is greatest, a considerable percentage of floor space must be left for aisles. The requirement of the Toronto by-law that girders must be figured for the same floor load per square foot as beams are figured is therefore entirely indefensible.

The completely covered proportion of the area sending load to a girder is variously estimated. Mr. Gunvald Aus, the consulting engineer on the world's greatest building—the Woolworth Building—favors making it two-thirds. A considerable number of cities fix it as substantially less than the full area. Chicago, Boston Philadelphia, Pittsburgh, Cleveland, St. Louis and San Francisco may be cited as instances. The reduction fixed by the building codes of these cities for most types of buildings ranges from 10 to 20 per cent., with an average of 15 per cent. That is, girders in most buildings, according to the codes mentioned, would be figured for only about 85 per cent. of the full possible floor load. The only kind of building for which the full floor load is required to be figured in the cities named is the warehouse or heavy mercantile building, and not even for these in all cases. The writer is thoroughly convinced that the calculation of girders for more than 85 per cent. of the full live load, except in the case of warehouses, is an extravagant and unnecessary procedure.

The practical result of the severe requirements of the present by-law with respect to girders has been estimated by the writer for different types of buildings and is as follows: For office buildings the increased cost of girders is approximately 4½ per cent.; for stores it is about 5 per cent.; while for factory buildings it is about 5½ per cent. The effect upon the cost of the beams, girders and columns is to increase it by from 1½ to 2 per cent. For a building in which these structural parts cost $100,000, the waste involved by this regulation of the specification alone is from $1,500 to $2,000.

REDUCTION OF LIVE LOAD ON COLUMNS.

Section 12, Sub-section 1, page 38.—Since the live load borne by a column in any story is derived from an area very large in comparison with the area tributary to either a floor-beam or a girder, a smaller floor live load should be used for figuring columns than for figuring floor-beams or girders. Admission of this principle is made in the by-law, but the probable maximum load, particularly for columns a long way down from the top of the building, is greatly overestimated.

Thus, to illustrate, in a typical office building, a column in the 12th story down from the roof must be figured for 76 per cent. of the maximum loads to be carried by the roof and all the floors above while most structural engineers consider 80 per cent. of the full specified live load as adequate for girders and even many of the building by-laws require only 85 per cent. of the full floor load for girders. The absurdity involved is most evident when it is remembered that the area which must be covered for a *full* load on the column mentioned is 24 times that which must be covered for a full load on a girder. Surely if not more than 80 or 85 per cent. of an area delivering load to a girder is likely to be fully loaded, an estimate of a full load on 76 per cent. of an area 24 times as great is altogether illogical and unsound.

The unreasonable demands of the by-law in this particular may be shown in still another way. For the column in the twelfth story down from the roof, after allowing for a full snow load on the roof and the weight of furniture, office equipment, safes, etc., on all floors, no less than 5,000 people would, in an average case, need to be massed about this column on the area contributing load to it in order to realize the load for which the Toronto by-law would require the column to be figured. The writer has estimated that even in a building with first-class elevator equipment it would take 3½ hours to distribute these 5,000 persons to the various floors, with none descending.

While the exacting character of these regulations respecting column live loads is less striking for columns nearer the roof than for the one forming the subject of the illustration, the waste involved is considerable, and what is more, entirely indefensible.

Corroboration of the conclusions expressed above may be had in the investigations of Messrs. Blackall and Everett, to which reference has already been made. In the three office buildings examined, while the greatest live load found in any room on any floor in any building was 40.2 pounds per square foot, the average of the maximum loads for all floors did not exceed 17 pounds per square foot in any one of the three buildings. It thus appears that the average maximum for *all* the floors is less than one-half of the maximum probable load on any one floor, and that columns in the lower stories of buildings, except storage warehouses, need not be designed for more than one-half of the specified maximum loads on the floors above. The proportion should, of course, gradually increase to 100 per cent. as the roof is neared.

That a much greater reduction of live loads on columns than is permitted in Toronto is sanctioned by good practice may be gathered from a study of the opinions and specifications of eminent structural engineers, and of the most recently revised building codes. Some years ago a notable paper on "The Structural Design of Buildings" was presented to the American Society of Civil Engineers by Mr. C. C. Schneider, one of the three engineers who are rebuilding the Quebec Bridge, and from the discussion of this paper by the ablest structural engineers of the continent it was shown that engineers are unanimous in their approval of live load reductions for columns much greater than are allowed by the Toronto by-law. This opinion was embodied in the authoritative "General Specifications for the Structural Work of Buildings" subsequently published by Mr. Schneider. Turning to the building codes, it is found that Chicago, Boston, Baltimore, St. Louis, Minneapolis, Providence, and San Francisco all allow greater reductions than are permitted in Toronto.

As a result of the severity of the Toronto by-law in the matter of column live loads the cost of columns in buildings over five stories in height is increased from 3 to 10 per cent. and the effect on the cost of the beams, girders and columns of the building is to increase their cost from three-quarters of one per cent. to two per cent. For a building in which these parts cost $100,000 for this particular item alone the waste involved would be from $750 to $2,000, depending on the number of stories.

REINFORCED CONCRETE CONSTRUCTION.

Pages 154 to 183.—Objection is made to the provisions of the present by-law respecting reinforced concrete on the following general grounds:

(1) The strength and reliability of this form of construction is underestimated.