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English and Canadian Concrete Regulations

Comparison Between Toronto's By Law Regulating Reinforced Concrete Construction and the New By-Law Recently Adopted By the London County Council—London Adopts 180 lbs. per sq. in. Shearing Stress and Favors Hooking the Ends of Reinforcing in Beams

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COMPARING the new by-law or regulations adopted by the London County Council with By-law No. 6401 of the City of Toronto (both of these by-laws relate to the regulation of reinforced concrete construction within the municipal limits), the writer finds that in a great many cases not only the Toronto practice but also the American practice varies considerably from that adopted in London, England.

It will be noticed in the following tabulated comparison that the London shearing stress is given as a maximum of 180 lbs. per square inch, while Toronto gives 150 lbs. per square inch. Chicago gives 120 lbs. per square inch and New York 120 lbs. per square inch, but these two cities state that this may only be used when all the diagonal tension is taken up by the steel.

None of these by-laws give formulæ for figuring the diagonal tension, and in fact most of the authorities on the subject confess that it is practically an indeterminate question. Prof. Talbot, in Bulletin No. 67 of the University of Illinois, states on page 9:—

"It is evident that the value of the diagonal tension is generally indeterminate. No working formulæ are available. For this reason it is the practice, now becoming nearly universal, in beams without web reinforcement to calculate the value of the vertical shearing unit-stress, v, and to use this as the measure or means of comparison of the diagonal tensile stress developed in the beam; with the understanding, of course, that the actual diagonal tension is considerably greater than the vertical shearing stress. It has been found that the value of v developed in beams will vary with the amount of reinforcement, with the relative length of the beam, and with other factors which affect the stiffness of the beam."

The formula given by Prof. Talbot, and usually adopted, is:—

$$t = \tfrac{1}{2} f \pm \sqrt{\tfrac{1}{4} f^2 + v^2}$$

where f = intensity of horizontal fibre stress,
v = intensity of vertical or horizontal shearing stress at point in beam.
t = diagonal tension.

The London County Council apparently figure their shear considering it to be a lattice girder, the compression being taken by the concrete and the tension by the steel rods. This appears to be a more reasonable method of looking at the subject, as it gives a very complete method of calculating the tension in the steel.

The compression in the concrete, taking a 1:2:4 mix as the basis of our discussion, is not as high as what we are allowing in Toronto, as we have adopted practically the Chicago by-law, which allows 700 lbs. compression for the extreme fibre stress in bending, and 18,000 lbs. for the steel, whereas London only allows 600 lbs. for the concrete and 16,000 lbs. for the steel.

We make the proviso, however, that where 18,000 lbs. is used, the elastic limit of the steel must be at least 54,000 lbs.

London's method of figuring the resisting moments are what are generally adopted universally by all authorities. They give a table showing certain values for concrete columns in which they state that the helical is the most effective, the circular hoops being next in value, allowing the least values for the rectilinear sections. Our by-law does not cover this point so thoroughly. The London by-law gives a straight-line formula for pillars and columns which varies considerably from what is given in Toronto's code.

Referring to the reinforcing in beams, London seems to lay great stress upon the ends of the reinforcing members being hooked. When this is done they allow considerably higher values than when the rods are straight. Up to date, no extensive tests have been made in America, so far as I am aware, which will verify the adoption of much higher stresses when the material is hooked.

Bulletin 67 (page 63) and Bulletin 29 (page 50) of the University of Illinois, give a few cases where the ends have been hooked, but the results do not seem to bear out the London County Council's conclusions on the subject.

Hool, Volume 1, recommends that the ends be hooked, but does not give any data showing the difference in strength when they are hooked and when they are straight.

Taylor & Thompson, in their 1916 edition, page 419, give some tests conducted by Prof. Bach in 1908 and 1912, in which the professor is of the opinion that the hooking of the rods prevents the slipping of the bars almost as much as 50%, and thereby increases the strength of the beams considerably.