THE FLAT SLAB SYSTEM IN FLOOR CONSTRUCTION

NOTES DESCRIPTIVE OF ADVANCES IN REINFORCED CONCRETE FLOORS IN PAST DECADE—COMPARISON WITH BEAM AND GIRDER SYSTEM—BEHAVIOR UNDER LOAD

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THE flat slab system of reinforced concrete floor construction may be defined as that system in which the load is carried from the slab directly into the columns without the use of floor girders or beams, the columns usually being built with a wide flaring top. One of the earliest engineers to make use of this system was Mr. C. A. P. Turner, of Minneapolis, Minn., who first described it in "The Engineering News" October 12th, 1905. In the course of his practice Mr. Turner had found that long span slabs were much more economical in general than those of shorter span and, after building panels up to 24 feet in span, he began to wonder if it were necessary to put in any ribs at all. He investigated the question thoroughly and developed a system of flat slab construction which he called the "mushroom" system. The word "mushroom" is his patented trade-mark, and in using this word to designate flat slabs other than those designed by him, an incorrect use of the term is made. Mr. Turner's patent covers the peculiar arrangement of steel over the column head used in his system, and shown in Fig. 1.

The principle of eliminating all beams and girders was also taken up by other parties, and several other patents taken out regarding it. Probably the first building to be constructed with this type of floor was at the plant of Proctor and Gamble, Armourdale, Kansas, which was built in 1903 from the designs of L. J. Mensch.

The owners and occupants of buildings were quick to appreciate the many advantages which this form of construction possesses, as compared to the beam and girder system. It has come into extensive use, and seems likely to largely supplant the older type, especially in such buildings as warehouses where very heavy floor loads must be provided for.

Since all loads are carried directly to the columns, all reinforcing metal must centre there. The steel is laid in bands about seven-sixteenths of the span in width, a band running along each side of the panel, and one along each of the diagonals. Thus each column has four continuous bands of steel passing over it. Fig. 1 shows the arrangement of the bands. Since the slabs are considered continuous over the supports the metal will lie at the bottom of the slab in the centre of the panel and in the upper part of the slab over the column. The steel passing over the column head is supported on a steel frame which holds the bars in place, takes some direct tension in the top of the slab, and aids in conveying the stresses to the columns. The latter are commonly built with a wide, flaring head in order to keep the shearing stresses down to the permissible values. The structure has been likened to an umbrella at each column, with the rest of the floor suspended from the edges of the umbrellas.

In comparing the flat slab system with the ordinary beam and girder system, the most obvious advantage of the former is the total elimination of projecting ribs below the bottom of the floor slab. Besides being a distinct improvement from the æsthetic point of view this permits a better distribution of light. In any building the light which is reflected from the ceiling is an important consideration. Figs. 2 and 3 show graphically how projecting ribs interfere with this reflection and the even distribution of light obtained with the flat slab system.

It also greatly simplifies the erection of shafting, as there is no interference by beams or girders. In the installation of sprinkler systems great economy results. There is nothing to prevent the water from spreading out evenly in all directions, and whereas it is often necessary to run a line of sprinkler heads down each side of a deep girder, one line would serve the same purpose if the girder be dispensed with.

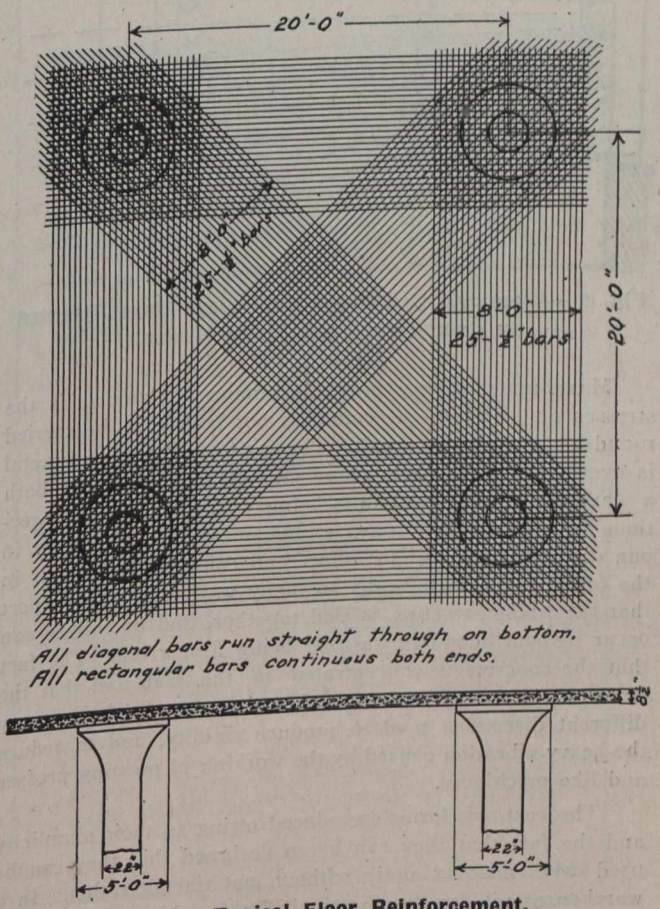

Fig. 1.—Typical Floor Reinforcement.

The height of any building required to obtain a given clear story height is reduced with a corresponding reduction in the cost. For instance, a building for the Toledo Lamp Works was originally designed for a beam and girder system with a 5-inch floor slab, 13-inch x 29-inch longitudinal girders and 10-inch x 23-inch transverse beams at 10-foot centres. The flat slab system finally adopted provided for a floor slab of a uniform thickness of 7 inches. This reduced the story height by 22 inches, which in a four-story building amounted to 88 inches, or more than seven feet. It was estimated that this change in plan meant a saving of from six to seven cents per square foot of floor area. Again, in the Grellet-Collins