Siward's How Water Tower

Extract from an Article in The Structural Engineer, January 1957

by JOC Ritchie

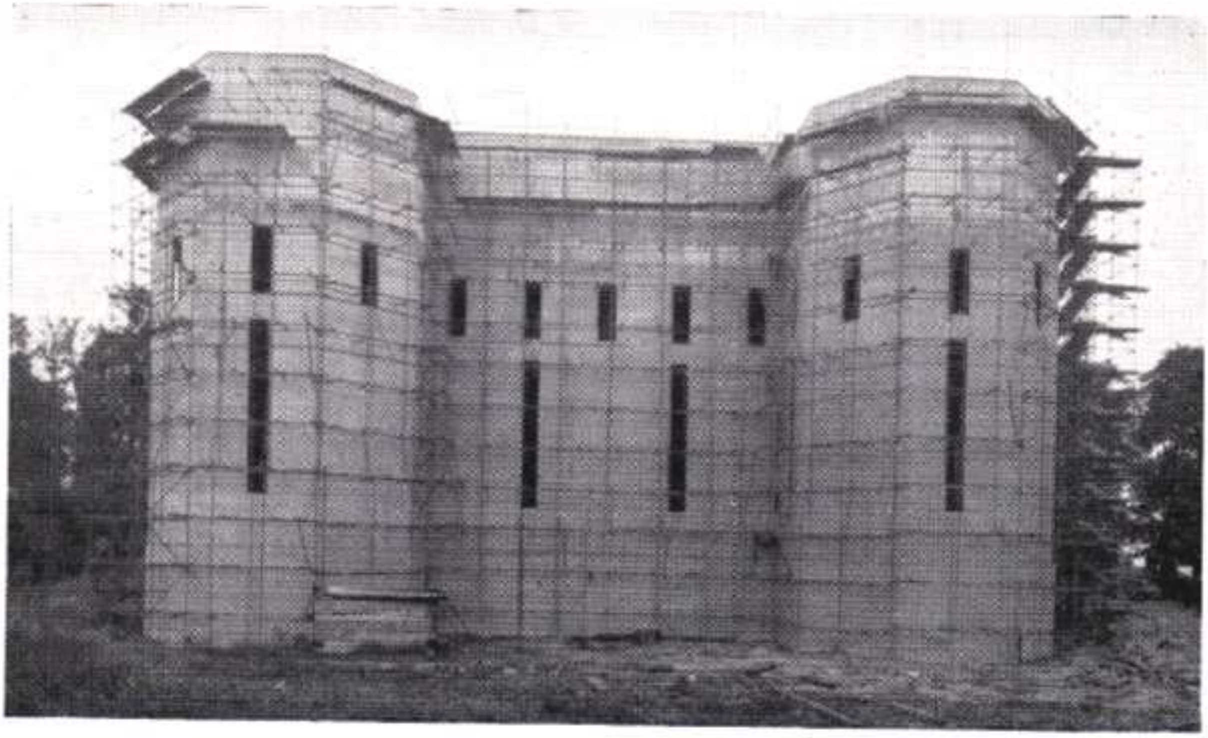

Plate 11.—Siward's How Water Tower (nearing completion), York Waterworks Co.

A Modern Tower for an Ancient City

The topography of the City of York and its environs being such that no site of sufficient elevation existed which could accommodate essential additional water storage, the York Waterworks Company was obliged to investigate the possibilities of affording this storage in the form of an elevated Water Tower of one million gallons capacity, probably as large as any yet constructed in this country.

A preliminary survey of possible sites for such a tower left no doubt in the minds of the engineers responsible that Siward's How, an ancient Tumulus which lies about 2½ miles to the east of the city, was the most suitable one for the purpose and permission was obtained from the Ministry of Works to erect a tower immediately adjacent to this Ancient Monument.

Those responsible for the preservation of the amenities of this noble city were naturally concerned that a structure of this magnitude should be in keeping with the aesthetic dignity of which it is so justifiably proud; but it was felt that no attempt should be made to camouflage the purpose of the structure.

Architectural opinion confirmed this view but stressed the desirability of breaking up the skyline of the structure in view of its essentially massive proportions.

Bearing these requirements in mind, several alternative proposals were considered before a scale model representing the final form was made and submitted to The Royal Fine Arts Commission for an expression of their opinion. As their approval of the model was unanimous, the Waterworks Company had no hesitation in proceeding with the design and construction of the tower accordingly. (Plate 11.)

Unfortunately, as soon as Ministerial approval to proceed with the scheme was given, it became extremely difficult to obtain delivery of steel reinforcement within a reasonable period of time, so it was decided to redesign the foundations in mass concrete so that a start could be made on the constructional work, pending receipt of the first deliveries of reinforcement.

It will be seen (Fig. 11) that the shape of the tank and supporting structure on plan takes the form of a large central square portion, each corner of which is eclipsed by an octagonal tower seven faces of which are revealed.

The central portion of the 15 ft. deep tank is 83 ft. 6in. square, each octagonal portion having an in-radius of 17 ft. 9 in. and the whole tank being divided into four separately operable compartments. Its walls are of the vertically spanning slab type, the main walls varying in thickness from 16 in. at the base to 9 in. at the top.

The tank floor takes the form of an 8 in. minimum thickness slab spanning on to secondary beams at 6 ft. centres which react on to main beams spanning on to the supporting columns which are spaced at approximately 12 ft. centres in both directions. The roof slab, which is 4½ in. thick, has a similar arrangement of main and secondary beams.

Like the Spalding Tower, this one also has an observation gallery and central valve operating platform below tank floor level; but in this case the gallery also carries a ring inlet-outlet main with controlling valves and branches, serving all four compartments of the tank. The overflow and washout valves only being accommodated on the central platform from which access is again given by means of a spiral staircase through access shaft and pent house to all compartments of the tank.

Apart from its shape, the supporting structure below the gallery level is in no way unusual, consisting of a series of a hundred 20 in. square columns braced together at ground and one intermediate level. Its corner towers are similar to each other with the exception of that at the South West corner which accommodates the main valve control house on its ground floor from which a reinforced concrete staircase leads up to the Gallery. There is, incidentally, an additional access shaft without a staircase, passing through the tank to the roof of this tower to facilitate the passage of materials during tank maintenance periods.

Lavatory accommodation is provided on the ground floor, the remainder of the area being intended for use as a store for certain of the Company's equipment.

Again like the Spalding Tower, the external screen walls have been bush hammer dressed with similar narrow margins, the tank walls being finished smooth. The window openings in the screen walls generally are unglazed, but those of the S.W. or Access Tower are glazed with steel framed windows.

Reinforced Steelwork

In the case of all the reinforced concrete towers referred to in the foregoing descriptions, the Reinforced Steelwork System of construction has been employed in the whole or some part of the structural framework.

In this system (Fig. 12), one part of the essential reinforcement employed consists of a comparatively light structural steel framework capable of carrying all the temporary formwork, the dead weight of the wet concrete and all other loads incidental to construction. The other part consists of plain round mild steel bars which are rigidly located relative to the R.S. Section by means of " Suspender Clips " which not only serve the same purpose as the rivets of a plated steel girder, but also afford the means of securing the bolts suspending the temporary formwork which requires no other external support or propping.

In accordance with this method of construction, the temporary formwork may be released for re-use at much shorter intervals of time than is called for in the case of normal reinforced concrete.

In water retaining structures, this special form of construction has an important additional advantage in that, as part of the steel reinforcement is pre-stressed under the constructional loads when the concrete sets around it, the ultimate tensile stress in the concrete is considerably reduced and the factor of safety against leakage correspondingly increased.

Some Unusual Problems affecting Existing Towers

Correcting a Serious Tilt

Although it is a comparatively simple matter to make provision in the design of a water tower structure for counteracting the effects of uneven subsidence which is anticipated, it is quite another problem if such subsidence occurs when it has not been anticipated.

Such problems are fortunately rare, but an interesting example did occur some 25 years ago in the case of a water tower of the Intze form constructed at Skegness and was described in an interesting paper entitled " The Leaning Tower of Skegness " presented by Mr. F. W. M. Ruck to a meeting of The Society of Engineers in 1952.

Mr. Ruck related how this 110 ft. high 200,000 gallons capacity water tower (Fig. 13) commenced to settle in course of construction, and when filled with water a total settlement of 12 inches was recorded in addition to which the tower began to tilt.

Investigation by the Authorities' Consulting Engineer, Sir Cyril Kirkpatrick, revealed the cause of the subsidence to be due to the flow of tidal water through the silty mud below the clay bed on which the Tower was founded, and it became apparent to him that if this silt could be contained, the Tower might be stabilised. He therefore decided to have a ring of steel sheet piling driven around the outer edge of the reinforced concrete foundation raft, three quarters of which would penetrate into the hard glacial clay below the silt, the remaining quarter of the ring on the high side of the Tower being driven only to the underside of the surface clay, thus leaving a gate in the ring.

The foundations of the Tower were then loaded on the high side with some 130 tons of sandbags, and a

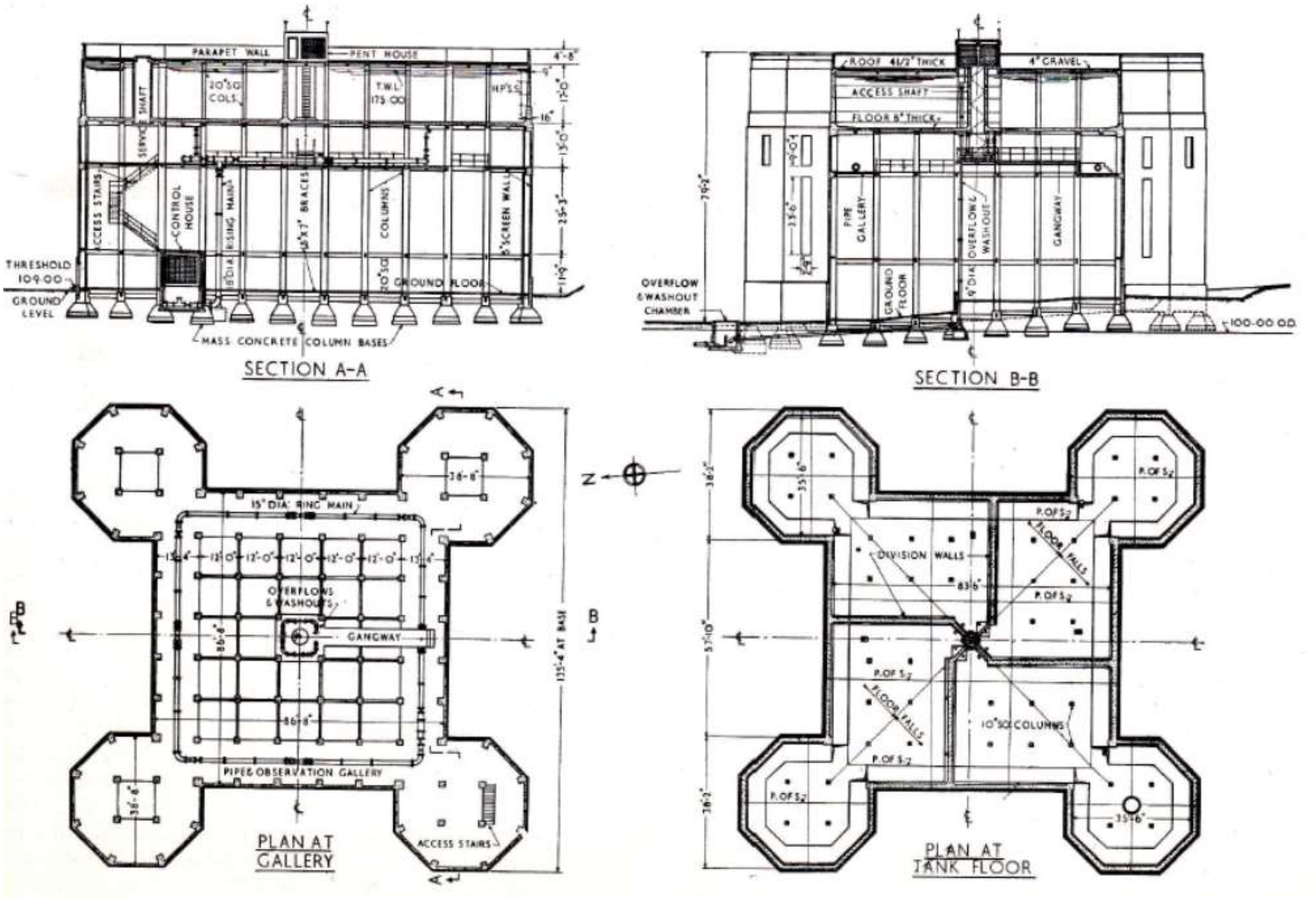

Fig. 11.—Siward's How Water Tower—The Yorks Waterworks Company

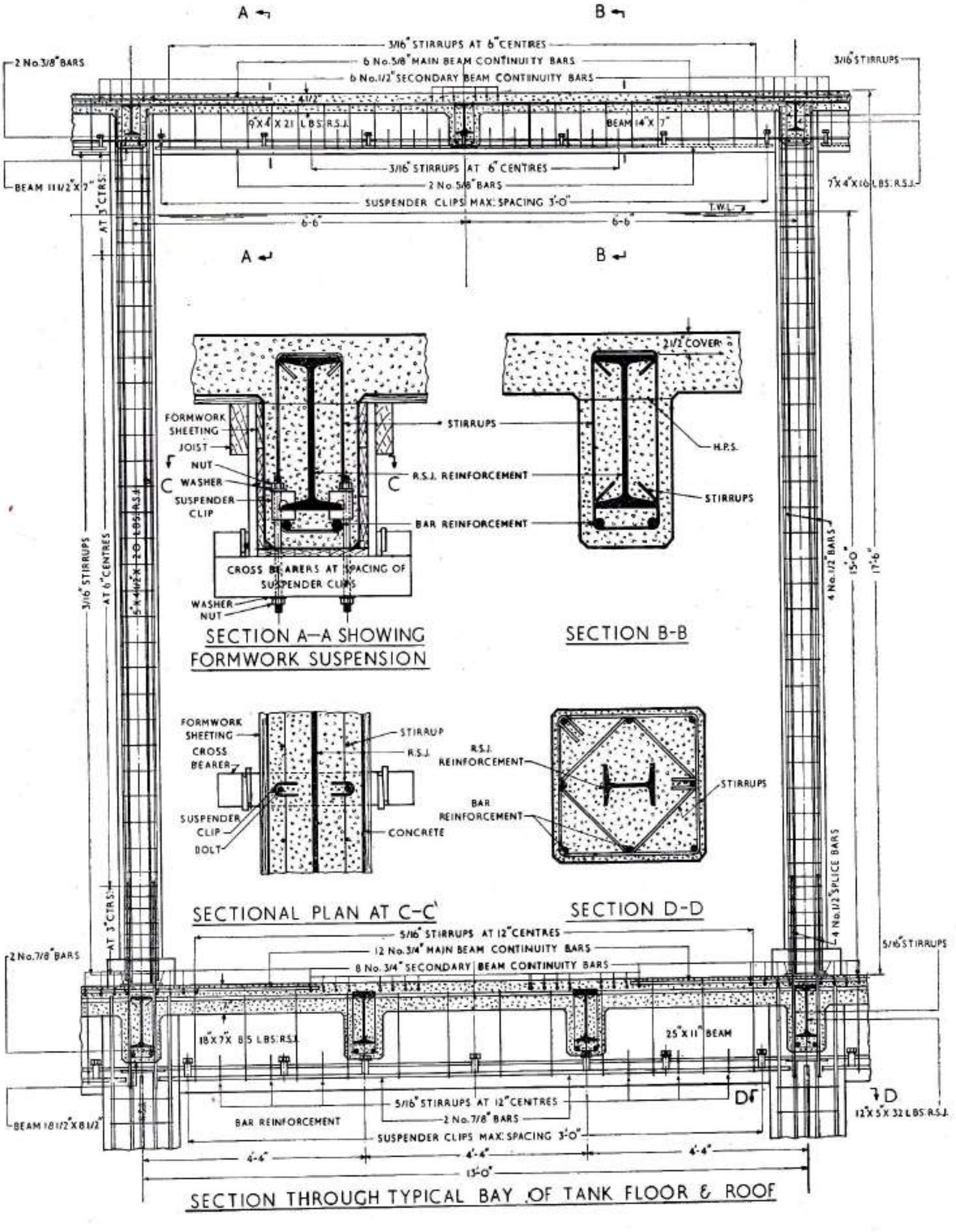

Fig. 12.—Reinforced Steelwork used in Water Tower Tank Floors and Roofs