

tom of the excavation. By carefully removing this sand and at the same time forcing the casing, a foot or more could be gained before another rush of sand and water would temporarily suspend the work, making progress slow.

The leaks which occasionally developed at the joints had meanwhile carried so much sand and clay into the excavation that the surface of the ground had cracked and settled over an area 40 feet in diameter around the mouth of the well. This sinking finally became so marked that the decision was made not to go any lower, for although the last section had not been put down an extra 7 feet of depth was gained by the settling of the ground at the surface. Before preparations could be made to build the concrete lining, however, a heavy flow of water broke through between the fourth and fifth sections and the subsequent movement of the soil around the casing squeezed the latter to an egg shape. Fearing the entire casing might collapse, the well was allowed to fill in order to balance the pressure on both sides of the casing. As this occurred late in the fall, operations were suspended until spring.

A steam driven deep well pump, with a Cook well point, was set up when work was started in the spring, and proved very satisfactory in keeping down the water. When the latter had been removed it was found that about 20 feet of material had filled in at the bottom of the excavation. As soon as this was removed the sand again began to come in, but the bottom was readily sealed with two layers of sacks of concrete. The water was then permitted to rise in order to relieve the pressure on the concrete while it was setting. When this concrete was hard, the water was drawn down again and 30 inches of concrete laid over that in the sacks. A rectangular opening was left in this floor for the well point on the suction of the deep well pump. This opening was covered with steel plates placed around the well point and a 12 inch concrete floor laid over the whole bottom. A 5 inch threaded pipe fitted with a flange was also placed through the floor to prevent the water

pressure coming on the latter if the pump failed. This 5 inch pipe was provided with a blank flange tapped for a 1 inch and a 2 inch pipe which was used later in filling the opening around the well point.

The concrete lining was placed in forms built of 2 by 4 inch lagging spiked to circular ribs. These forms were made in sections 10 feet long, the length of each section of the casing, and were built in six segments. New ribs were required for each section owing to the changes in the diameter of the excavation, but the lagging was used repeatedly. The forms were made above ground and the segments lowered into the well, where those of a section could be bolted together and beveled ready for the concrete in 2 or 3 hours.

The angle braces on the casing which were not already sheared off when the water was drawn down in the spring were removed. The joints between the sections were then calked with fresh oakum, and dried white pine tongue and grooved wedges were driven into them with sledges. In spite of these precautions the joints continued to leak so they were covered with strips of tin, leaving a hollow at the joint through which the water was conducted to a pipe leading through the forms.

The concrete mixture consisted of 1 part Portland cement, containing 1 1-2 per cent. by weight of Medusa waterproofing compound, 2 parts of coarse river sand and 4 parts of crushed limestone, which would pass through a 1 inch screen and be held on a 1-4 inch screen. Tests of various waterproofing substances, such as a mixture of alum and soft soap and hydrated lime, were made before the work was commenced, with the result that the Medusa compound was adopted. Test blocks of concrete containing 1 per cent. of this compound mixed with cement showed no penetration over 1-16 inch in depth after being soaked for 48 hours in hot water, while plain concrete mixed in the same manner was found to be saturated under the same conditions.

No night work was done in placing the concrete, but the damp air in the well prevented the latter from attain-

ing much of a permanent set over night, and the surface of the finish work was carefully washed with neat that had been left in the concrete to handle the water from the joints in cement each morning. The water was allowed to rise in the well as the concrete was brought up, and after the work was finished was allowed to stand for six weeks so the concrete would be sufficiently hardened to resist the pressure head that would be brought against it. When the water was pumped out the various pipes the casing were filled. The compartment containing the point of the pump was finally filled through the 2 inch pipe in the flange on the 5 inch pipe left in the floor. A certain amount of seepage was expected through the lining, but after remaining damp for several months the concrete became as dry as concrete above ground.

The 2 to 3 inch cracks in the surface of the ground around the mouth of the well were washed full of sand, and then a square several feet larger than the footing for the building was excavated to a depth of 14 feet, the upper 6 feet in sunken ground and the remainder in solid earth. The bottom of the excavation was then covered with sand on which the footing walls and piers for the tower were built, the remainder of the excavation being filled to the ground level again with earth. Elevations determined on the footing walls showed a slight settlement when the full load of the superstructure was first placed on them, but this has now ceased and the tower has not been strained in any way.

CONCRETE STEPS.

Concrete may be advantageously used in the construction of steps, particularly in damp places, such as areaways and cellars of houses; and in the open, where the ground is terraced, concrete steps and walks can be made exceedingly attractive. Where the ground is firm it may be cut away as nearly as possible in the form of steps, with each step left two or three inches below its finished level. The steps are formed, beginning at the top, by depositing the concrete be-