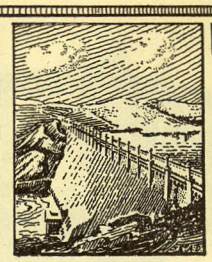
ENGINEERING



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Dams—High, Large, and Unusual

(Part 1—United States) [1]

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IN THE January, 1930, number of the New Reclamation Era was an article The Highest and Largest Dams in the United States and Abroad. Since the publication of that article construction of the Boulder Canyon project has been started, with the 730-foot Hoover Dam as its principal feature, and this outstanding monument of concrete has awakened a widespread interest in dams in general and the structure to be erected by reclamation engineers in the Black Canyon of the Colorado River in particular. This mammoth dam, which is to span the Colorado River between the States of Nevada and Arizona, will be the highest in the world, in fact, about twice as high as the Diablo Dam, which at present holds that distinction. In a few months the Owyhee Dam on the Owyhee (Federal) irrigation project in eastern Oregon will be completed and it will exceed the 389-foot Diablo by 16 feet, being 405 feet from the foundation rock to crest. The Sautet Dam, a thin concrete arch, now under construction in France, will overtop the Owyhee, with a maximum height of 446 feet.

Building dams is an every-day story with reclamation engineers. Their record to date in 26 years of construction work is 124 dams, and four are now under construction—the Hoover in Arizona-Nevada, Owyhee in Oregon, Cle Elum in Washington, and Thief Valley in Oregon. Among the notable structures built by the Bureau of Reclamation are the Arrowrock, Shoshone, Pathfinder, and Roosevelt Dams. Every schoolboy is familiar with the last-mentioned structure, which was named after President Theodore Roosevelt. Many automobile tourists traveling the southern route turn aside at Phoenix, Ariz., to visit Roosevelt by way of the scenic Apache Trail. The Madden Dam being constructed by the Panama Canal bureau on the Chagres River at Alhajuela, Panama, was designed by engineers of this bureau; also the Cat Creek Dam now nearing completion by the Navy Department at Hawthorne, Nev. The engineers in the Denver (Colo.) office of the Bureau of Reclamation are often called upon to act as consultants on the design and construction of dams. In 1910, the bureau completed its first high dam, the Shoshone on the Shoshone River in Wyoming. Closely following this was the Roosevelt in Arizona, finished in 1911.

[1] Dams—High, Large, and Unusual (pt. 2, United States, and pt. 3, Foreign Countries) will appear in subsequent issues of the Era.

HIGH DAMS

The Diablo Dam near Rockport, Whatcom County, Wash., in the heart of the Cascade Mountains, is temporarily the highest of all dams, with a maximum height of 389 feet. It was completed in 1930 by the city of Seattle as a part of the upper Skagit River power development. The dam is located in a solid granite gorge, which is only 125 feet wide at the base of the structure. The type is a constant radius arch, with gravity wings, the length of the arch being 588 feet and total crest length, 1,180 feet. At the crest the dam is 16 feet in thickness and 140 feet at the base. There were 350,000 cubic yards of concrete placed in the structure. The construction period was from January 1, 1928, to September 15, 1930, the first concrete being placed July 12, 1928. To divert the river during construction a tunnel 20 feet in diameter and 650 feet long was driven through the canyon wall. The upstream cofferdam, 250 feet long, was faced with sheet steel and was built of great fir logs tied together and weighted to the river bed with large rock. Behind the dam 90,000 acre-feet of water can be stored and a lake 6 miles in length is formed. The installed capacity of the power plant is 167,000 horsepower with an ultimate capacity of 225,000 horsepower. Among the items of work was the excavation of 230,000 cubic yards of solid rock. The power tunnel is 19 feet 6 inches in diameter and 2,000 feet long. It is said that a trip up the Skagit River Valley to Rockport and then up the gorge to the dam will provide the visitor with some of the finest scenery in America.

Among the nonoverflow, solid gravity, curved-in-plan dams the Pardee in California is the highest at the present time. It is a part of the Mokelumne River project, which provides a mountain-water supply to the East Bay Municipal Utility District comprising Oakland and other cities on the eastern shore of San Francisco Bay, and is located near Valley Springs, in the foothills of the Sierra Nevada Mountains. The dam is 358 feet high, 1,337 feet long on the crest, and contains 617,700 cubic yards of concrete. The structure is provided with inspection and drainage galleries. There are two 72-inch and two 42-inch cast-iron pipe sluiceways through the dam, valve-controlled at the lower end and with roller gates at the upper end. A power plant of 15,000-kilowatt capacity at the base of the dam receives water through two 72-inch pipes. The contractors placed 1,600 cubic yards of concrete in eight hours, 3,600 cubic yards in one day, 67,000 cubic yards in August, 1928, and 514,000 cubic yards in 12 months from April, 1928, to April, 1929, which was an outstanding accomplishment in mixing and placing concrete.

The 372-foot Pacoima Dam, near San Fernando, Calif., tops all structures of the variable radius arch type. It was completed in 1929 by the Los Angeles Flood Control District. The stream bed width at the site is only 65 feet. At the base the dam is 94 feet thick and it rests on a foundation of granite.

EARTH AND ROCK FILL DAMS

Among the earth-fill dams the Cobble Mountain near Westfield, Mass., built by the city of Springfield to store water for the city supply is the highest, towering 245 feet above Little River. It is 700 feet long across the crest, 50 feet thick at the top, and 1,500 feet at the base, and contains 1,800,000 cubic yards of earth deposited by the hydraulic method. There is a cut-off wall of concrete, and the upstream slope is faced with rock. Power development is an important feature, as the sale of power pays all the bills. Only seven earth-fill dams have been built in this country to a height of 200 feet or over.

The Salt Springs Dam, 332 feet in height, is the highest rock-fill structure in the United States. It is a power dam built by the Pacific Gas & Electric Co. on the North Fork of the Mokelumne River, near Stockton, Calif. The rock is faced with concrete; the fill is 15 feet thick at the crest and 900 feet thick at the base. There are 3,000,000 cubic yards of rock in the dam. A close second to Salt Springs in height is the Morena, a 278-foot rock-fill dam near San Diego, Calif., a part of the San Diego water supply system, which was completed in 1930. Then comes Dix River, a power dam at Danville, Ky., which is 270 feet high, 910 feet long, and contains 1,747,000 cubic yards of rock. The San Gabriel No. 2 Dam recently authorized for construction by the Los Angeles County Flood Control District of California, will be of the rock-fill type and 290 feet in height. It will take the place of the San Gabriel Dam, on which construction work was started in 1929 but suspended because of unsafe foundation and abutment conditions which developed. This dam will be second in height to the Salt Springs Dam. The three dams named—the Salt Springs, Morena, and Dix River—are the only structures of the rock-fill type which have been built in the United States with heights of over 200 feet.

In the Salt River Valley near Phoenix, Ariz., is the Lake Pleasant Dam, the highest and largest multiple-arch dam constructed to date. It has a maximum height of 256 feet, and a length of 2,146 feet comprising 26 arches with hollow or double-wall buttresses between. The buttresses are spaced 60 feet apart on centers and are 18 inches thick at the top and 5 feet 6 inches thick at a distance 180 feet down. They have a uniform outside dimension of 16 feet, leaving a clear span of 44 feet for the arches. The spillway, which is located in a natural saddle about 1,000 feet from the western end of the dam, is 750 feet long and has a capacity of 150,000 cubic feet per second. Twenty-nine Taintor gates, each 23 feet long and 16 feet high, regulate the flow. The Lake Pleasant Dam is on the Agua Fria River, and was built by the Maricopa County Water Conservancy District No. 2 for the irrigation of 40,000 acres, principally citrus-fruit lands. In 1928 cracks in the buttresses endangered the safety of the structure and following the advice of a board of consulting engineers, the spillway was lowered 24 feet to provide for its present capacity of 150,000 cubic feet per second.

A considerable number of dams of the multiple-arch type have been constructed in recent years, among them being the 170-foot Big Dalton, the 180-foot Sutherland, 175-foot Little Rock, and 154-foot Florence Lake, all in California. Closely

related to the multiple-arch type is the Ambursen or flat-slab reinforced-concrete type of dam, of which over 200 have been built in the United States and abroad. The upstream face is built of flat reinforced-concrete slabs instead of masonry arches, while the buttresses are similar to those of the multiple-arch dam. The Stony Gorge Dam, 125 feet in height, on the Orland (Federal) irrigation project in California is the only Ambursen dam built by the Bureau of Reclamation.

UNUSUAL CONSTRUCTION FEATURES

The Coolidge Dam is the first multiple-dome type to be built and consists of three egg-shaped domes supported by two intermediate buttresses and the canyon walls. It was built by the United States Indian Service on the Gila River near San Carlos, Ariz., to store 1,200,000 acre-feet of water for the irrigation of 80,000 acres of the San Carlos project. It stands 249 feet high above bedrock, was completed in 1928, and cost $2,270,000. An interesting feature of the Yuma (Federal) irrigation project in southwestern Arizona is the Laguna diversion dam. It is a type of wier which has been in successful operation in Egypt and India for many years, but was new to this country.