Progress of Science: New

Engineering Technique

Four Gigantic Tunnels Clear Stream Bottom

Work of Diverting River Nearly Complete a Year Before Time Planned

Dam To Be Started Soon

150-Foot Excavation Necessary to Reach Bedrock

By G. Edward Pendray

The magnitude of the Hoover Dam project, where the waters of the treacherous Colorado River were turned into the first of four huge diversion tunnels last week, staggers human imagination. Every operation there involves calculation in millions—millions of cubic yards of concrete will be poured; millions of tons of sand will have to be dug, processed and transported; millions of cubic yards of rocks have been or will be removed. The project as a whole, including the dam and associated power, irrigation and water projects, will cost hundreds of millions of dollars.

In the desert Southwest water is more than money; it means life. Hoover Dam will back up a lake of water large enough to cover the State of New York to the depth of one foot—eleven times as much water as that impounded by the Elephant Butte Dam in New Mexico, twelve times as much as the great Assuan Dam on the Nile in Egypt. This huge reservoir will pour fertility over 2,100,000 acres or thirsty land. It will put an end to the menace of floods in Imperial Valley. In addition it will supply water to several populous cities, including Los Angeles and its environs.

Huge Power Plant To Be Built

Moreover, on its way to satisfy all these thirsts, the water impounded by the dam will be forced to yield up energy for industries as yet unborn. The power plant at Hoover Dam will be able to generate 1,000,000 horsepower, and will be equipped to furnish a continuous flow of energy totaling 663,000 horsepower.

Problems confronting engineers at Hoover Dam transcend mere matters of magnitude. They were faced with difficulties due to the isolation of the site, extremes of weather, the towering cliffs on either side of the river and the treacherousness of the river, one of the most unpredictable streams on the American continent. On the average, the Colorado River discharges about 22,000 cubic feet of water a second, but in flood time it often enlarges its flow to 300,000 cubic feet a second, a twelve fold increase.

The first step in taming such a river is to dispose of the water during the operation, leaving a dry bed in which to work. The Hoover Dam engineers undertook this by driving four huge tunnels—two on each side—through the solid rock of the canyon. These tunnels are each more than 3,000 feet long, and fifty-six feet in diameter, making a total of two and a half miles of tunnel.

The tunnels, one of which is now in operation, represent the preliminary step in damming the river. Two of them will handle the ordinary flow of the stream, even in high water. All four will be called into play in time of flood. Water is low at present, and diversion into the first of the tunnels has laid bare the bed of the Colorado River for the first time in its history, making it possible now to begin excavation for the foundations of the dam itself. Above the site of the dam there is now being erected a temporary cofferdam, to drive the water into the by-pass tunnels. Below, another temporary dam will be erected to keep the water from backing up. On the site proper it will be necesary to remove mud and sand to a depth of about 150 feet, to reach solid rock.

Tunnels Finished One Year Early

Small as they bulk in relation to the entire project, the successful completion of the four diversion tunnels nearly a year ahead of schedule was an engineering achievement which is a tribute to modern scientific methods and equipment. The length of the tunnels, the hardness of the rock, and especially the huge diameter of the bore, taxed the ingenuity of the engineers. Most of the equipment had to be specially designed for the task.

The first step was the driving of pilot tunnels twelve feet in diameter, which were put through the rock by ordinary methods. The enlargement to the final size was completed principally with the use of a novel apparatus developed by engineers at the site. This was the construction of a drilling "jumbo"—a series of platforms erected on a five-ton truck chassis, equipped with thirty pneumatic drills. Rock can be removed rapidly with this contrivance. It is necessary only to back up to the wall, and set the thirty drills going.

So much rock was removed that a serious problem of disposal arose. The best place to put it was in the bed of the river, where it was hauled by trucks and placed along the sides, making a road at the base of the cliffs. Another problem raised by the drilling operation was the volume of compressed air needed to operate the drills. More than 16,000 cubic feet of air a minute was required to meet the peak requirements of the schedule. To supply it three compressor plants were constructed, the air being fed to the points of operation through six-inch pipes.

The final step in constructing the diversion tunnels was lining them with an average thickness of three feet of concrete. The forms to hold the concrete in place on the sides, top and bottom of the tunnel were designed by the engineers especially for this job. They were of fabricated steel, and

Associated Press photos

Portals of two diversion tunnels on Arizona bank of the Colorado. Stream bottom at site of Hoover Dam now is freed for immediate work on excavation

moved along on a track which later became a part of the reinforcing of the concrete. The bottom section was laid first, then the side sections, and finally the top. The material for the upper sections was blown in place by pneumatic concrete guns feeding into eight-inch steel pipes.

Test for Concrete Plant

This concrete job afforded the companies co-operating in the Hoover Dam project an opportunity to try out the concrete mixing plant being built for the bigger task of pouring the dam, and also to test the system by which gravel is obtained, processed and transported to the site of the work.

The transportation of gravel, or aggregate, was one of the largest problems in the entire project. A total of 27,000,000 tons is being moved for the work. To transport this material, twenty-seven miles of railroad and a 1,000-foot pile bridge over the river have been constructed.

The river itself provided the gravel which the government engineers have designated for use in the concrete of the dam. The deposit, laid down in prehistoric times by flood waters, is on the Arizona side, eleven miles by road upstream from the dam site. The deposit is huge—a small desert pocket in itself, but engineers estimate that practically all of it will be needed, leaving a hole where the sand formerly lay.

When it comes to pouring the concrete of the dam, 45,000,000 cubic feet of it, a monster concrete plant now under construction will be brought into use. The placing of so much concrete with the speed and economy required by present-day construction is alone a tremendous task—one which is further complicated by severe weather conditions.

Consequently it was necessary to design a mixing plant that not only

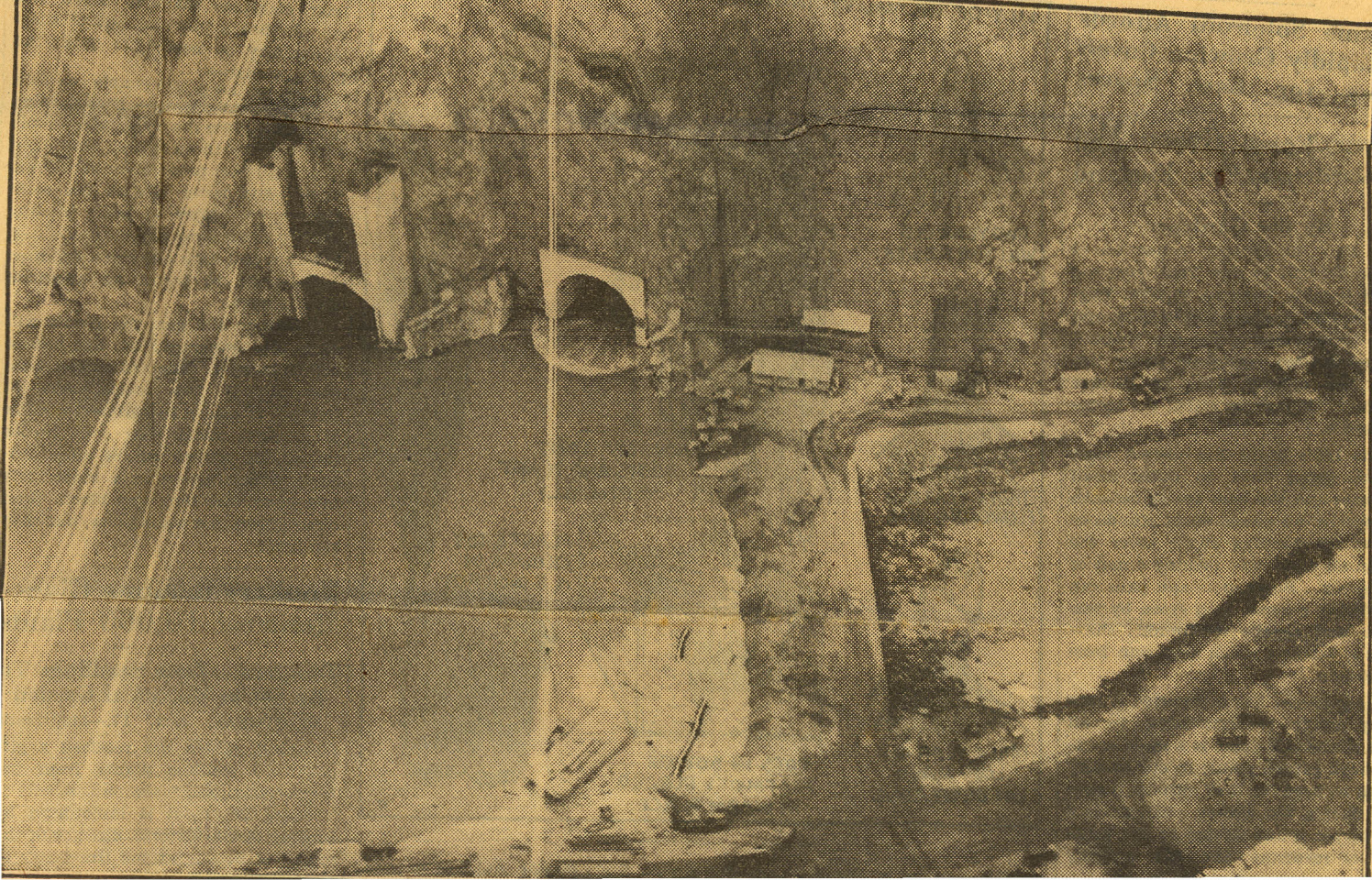
would exceed all similar plants in size and capacity, but also which would have the most advanced equipment for producing high-quality concrete continuously and dependably.

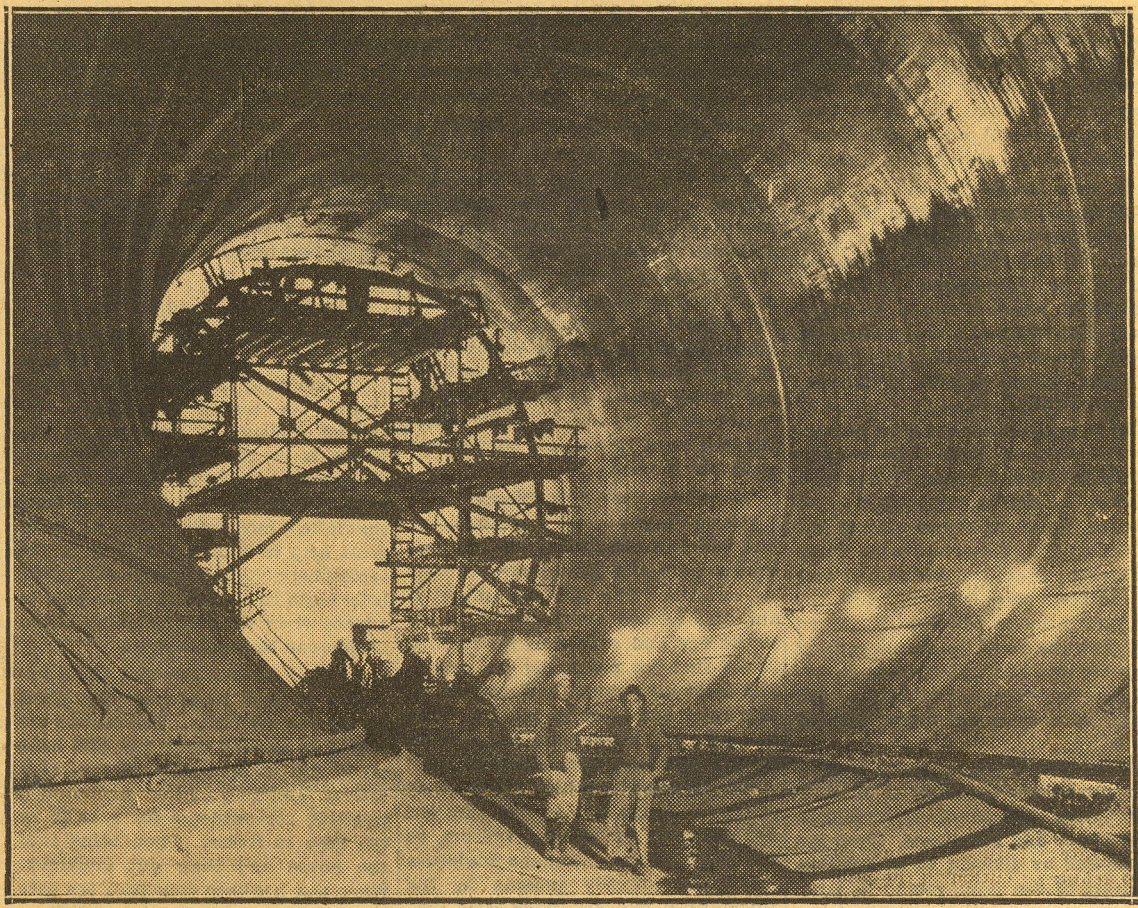
The concrete plants at the site will be able to produce 170,000 cubic yards of cement a month, working sixteen hours daily.

The dam was originally scheduled to be finished in six and a half years. The work has progressed so rapidly that this time may be reduced a year or more, making it possible to have the task completed at the latest by 1937.

The dam and powerhouse, however, represent only one part of the project. An engineering feat of almost equal importance will be the construction of an irrigation system in the Imperial Valley of southern California. Water passing over the Hoover Dam will be allowed, after it has yielded its energy in the form of electrical power, to follow its age-old course to a point about fifteen miles above Yuma, Ariz. There a long weir dam will be laid across the channel, resting on the sand of the river bottom, and the water will be diverted into a canal.

Opposite Yuma the canal will give up about an eighth of its water, which will be used to yield electrical power for the city. Afterward it will be siphoned under its former bed to the Arizona side, where it will irrigate a forest of grapefruit trees. The other seven-eighths will continue through the canal on the California side for a distance of 20 miles, ending in a network of capillaries which will bear life and bloom for the desert regions.





Gleaming concrete lining of one diversion tunnel before waters of Colorado River rushed through. More than fifty feet in diameter, these tunnels are largest of kind in the world