

Seven Wonders

*Seven modern wonders of civil engineering —
and some of the engineering wonders of Biblical times
on which they were based*

by The Reverend Ganse Little

In 1955 the American Society of Civil Engineers selected the Seven Modern Wonders of Civil Engineering in the United States of America. These were the Chicago Sewage Disposal System, the Colorado River Aqueduct, the Empire State Building, the Grand Coulee Dam and the Columbia River Basin Development, the Hoover Dam, the Panama Canal and the San Francisco-Oakland Bay Bridge.

All of us, in our day of scientific marvels, may well take a bow, but we should also make a bow to the past in the humility of an Isaac Newton who disclaimed credit in the words, "Remember, I was standing on the shoulders of giants." The seven modern wonders of engineering were superimposed upon the shoulders of the engineering of Bible times.

I am not speaking of the so-called Seven Wonders of the Ancient World (as of 200 B.C., roughly)—the Pyramids, the Hanging Gardens of Babylon, the Phidias Statue of Zeus at Olympia, the Temple of Artemis at Ephesus, the Colossus of Rhodes, the Tomb of Mausolus, and the Pharos of Alexandria.

These were all non-utilitarian projects, and I have purposely chosen to restrict our field of research to, first, useful work (as did the American Society of Civil Engineers in selecting its modern wonders); and second, to those structures and engineering projects which had a definite effect upon Biblical history.

By such restriction we place a very definite limitation upon the magnitude and grandeur of the engineering involved. No aqueduct, for instance, specifically related to Biblical history can compare with the

great Roman aqueducts. And so when I refer later to the aqueduct built by Hezekiah in Jerusalem, it isn't much of an aqueduct, judged by Roman or by modern standards, but it was an amazing piece of engineering for those ancient Biblical times.

In the Bible lands and times, as in the twentieth century in our own country, water was the primary concern, challenge, and problem of the civil engineer. How to secure water, how to control it, how to channel it, how to convey it, how to cross it, and how to use it taxed most of his budding genius and grit. Is it not significant that six out of the seven of the *modern* wonders selected by the ASCE in 1955 had to do with water problems?

The Bible lands were truly "a dry and thirsty land where no water is." At the time of the beginning of true history in the Old Testament, the time of Abraham, we find the first thing Abraham undertook when he reached "the Land of Promise" was to dig the well of Beersheba, because while the land was "flowing with milk and honey," it was not flowing with an abundance of water.

Many hundreds of years later, Moses — an engineer of no mean magnitude — was mainly concerned with water problems. In the course of the wilderness wanderings he struck water from "the rock," and water-bearing sandstone is still available in the same locale today to duplicate the "miracle." And his initial success in crossing "the Red Sea" (probably Lake Cardawil, a shallow 45-mile-long lake filled with red reeds) proves him to have been a close observer of wind, weather, and water conditions in the wilderness. He sweetened the bitter waters of Marah by casting in some specie of wood, obviously a primitive method of water purification.

"Seven Wonders" is an adaptation of a talk given by the Reverend Ganse Little, pastor of the Pasadena Presbyterian Church, at a meeting of the American Society of Civil Engineers in Los Angeles.

I. Sewage Disposal

But there was little water purification on a major scale in Moses' day, or for many generations thereafter. And there is nothing in the Bible or in Bible times comparable at all to Chicago's sewage disposal system.

Early civil engineers showed far more concern about how to get water *into* the community than how to get waste and refuse out of it. It is true that there were elaborate plumbing and disposal systems in Cretan Knossos (the Palace of Minos) in the Middle Manoean Period – 2200 to 1600 B.C. Mesopotamia in the time of Sargon and the Pharaohs of ancient Egypt provided private and complex systems of plumbing and disposal for the palaces of that day. But even these systems were available only where there was a plentiful water supply, plus the wealth of kings.

Throughout Biblical history and in Bible lands, sewage disposal was practically nonexistent. Jerusalem, for example, had its Valley of Hinnom, used in pre-Israelite times as the place of child sacrifice by fire. Josiah, in order to desecrate it permanently and thus render it unfit for such pagan ritual worship, began to use it as a place for the disposal of the waste, sewage and offal from both city and temple. Aside from bacterial purification, fire was resorted to as the chief reduction agent. Thus, Gehinnom (Valley of Hinnom) became Gehenna, symbol of "Hell" and the worms and fires thereof!

II. Aqueducts

As we give merited praise to the Colorado River Aqueduct, it may be well to think back across the centuries to the water tunnel of Hezekiah at Jerusalem. This is not Exhibit A of a great aqueduct system even in that day and time. Roman aqueducts are purported to have delivered 130,000,000 gallons of water per day throughout the Empire at the height of their development, and 90,000,000 gallons per day went into the imperial city of Rome itself.

We also remind ourselves that in the world of his day and time Pontius Pilate would never have been known as the Roman Procurator who passed judgment upon the unknown Galilean, Jesus of Nazareth, but rather as the constructor of a great system of aqueducts and other public works and projects throughout Judea.

But let's look for a moment at the Jerusalem of Hezekiah's day, in the year 705 B.C. Sennacherib is "descending like the wolf on the fold" and the fold is desperately in need of water. Hezekiah and his engineers soon saw that there must be some way of getting water from the spring Gihon – which was in a totally unprotectable site outside the city wall – into a more secluded spot, so that during the anticipated siege water could be brought into the city without too great a sacrifice of life. To answer this prob-

lem Hezekiah constructed the Jerusalem water tunnel. It was only 583 yards long, of which 362 yards were dug through a hill. By such means water was brought into a protected area which later became the pool of Siloam of Jesus' day. This tunnel shows the ingenuity and technique of those primitive days when men, equipped only with picks, began excavation from both ends of the project and met in the middle.

Sennacherib was the Assyrian general who, after the conquest of Jerusalem, also laid siege in this same campaign to Lachish, a city 20 miles to the southwest of Jerusalem and one of the great fortifications along the road to Egypt. Lachish itself had a very unique aqueduct system which tunnelled about 70 feet in one direction and then 80 feet in another direction, and from which had been excavated 500,000 cubic feet of solid limestone, all removed without explosives, drills, or cranes!

After this invasion Sennacherib went back to Assyria and 15 years later completed his own great aqueduct at Jerwan, bringing fresh water from the mountains to his capital at Nineveh 30 miles away. Three hundred yards of this aqueduct, 50 feet wide and 5 feet deep, was carried on masonry arches over the valley of a small stream which bisected it.

III. Structures

The Empire State Building was selected as one of the seven modern wonders of engineering in this country. There is nothing comparable, of course, in the Bible – unless you count the prehistoric tower of Babel. But there was Solomon's temple, constructed sometime between 973 and 933 B.C.

The thing that impressed me most in my research in this area was the variety of the work and the workers employed. Hiram, King of Tyre, furnished the major portion of the skilled workers in metal and in wood. The Israelites were never truly proficient as metal workers or as carpenters, but they excelled as stone masons. Metal and wood were relatively scarce in the so-called Holy Land, but stone was abundant.

The temple of Solomon was 60 cubits long, 20 cubits wide, and 30 cubits high. If you believe the Old Testament record, Solomon got together 108,000 talents of gold, and 1,017,000 talents of silver to pay for the building of this structure. (The smallest talent, it might be noted, weighed at least 58 pounds!) It took him only seven years to build this beautiful structure. He did it by virtue of pressing into service 30,000 native Israelites, in levies of 10,000 per month, working in the forests of Lebanon under the direction of Hiram's skilled foremen – plus 150,000 Canaanites, as hewers and carriers of stone, under Israelite direction. This was pure slave labor, just as in the pyramid days, and a labor force of this magnitude requires a sizable skilled force of what we would call civil engineers.

The size of the stones used in this operation varied

from one to two and a half tons, comparable to the type of construction in the pyramids. Some of them were 25 cubits in length, and we still do not have a complete answer as to how blocks of stone of this size and weight were cut, moved, and placed. Solomon's temple was destroyed at the time of the captivity of the Jews.

IV. Dams

The Grand Coulee Dam and the development of the Columbia River Basin was the fourth of the modern wonders in the United States, according to the vote of the ASCE. Again, the Bible cannot enter into competition but we may still marvel at the Lake Moeris Dam of ancient Egypt. This dam is not mentioned in the Bible but it had a profound effect upon Biblical history. Of interest is the fact that somewhere in the period of 2950 to 2750 B.C. — almost 5,000 years ago! — the Egyptians did attempt a huge masonry dam at Sadd-el-Kafara on the Nile. Actually this was to be a double masonry dam proposition with a rubble fill area extending 120 yards in length up and down stream between the two masonry dams. These dams were to be approximately 348 feet long at the top, 265 feet long at the bottom, and 40 feet above the stream bed. The work was never satisfactorily completed because the dams were overtopped in the process of construction by floods — and masonry dams were not attempted again by the Egyptians for many thousands of years.

The Lake Moeris Control Dam, constructed in about 2300 B.C., some 50 miles southwest of Cairo, consisted of two earthen dams. One of these diverted the flood waters from the Nile into the depression which became known as Lake Moeris — an area of 656 square miles, and containing 40,000,000 acre-feet of water when filled, the depression itself being situated about 150 feet below sea level. The second dam was to let the water back out of Lake Moeris downstream into the main channel after the flood waters had subsided.

Such a control system meant that before and after each flood of the Nile both of these dams had to be breached in succession, and then both of them had to be rebuilt. This was a tremendous labor even by the standards of engineers and workmen who were of a race of pyramid builders! This worked well for flood control. But anyone who cut the dam in years of normal flow or of reduced flow and diverted water into Lake Moeris, impounding it there, could thereby create a devastating famine in lower Egypt and adjacent areas.

V. Mining

Another of our modern wonders is the Hoover Dam, but instead of talking about more dams, let me expand at this point on mining and the use of metals in

Biblical times. According to Genesis, the first child born to Adam and Eve was a boy by the name of Cain. Cain means "smith" or "miner" — a curious name to give a child in the legendary history of a race supposedly composed of farmers, shepherds, and nomads! But one of the descriptions of the Promised Land in the Old Testament is a "land whose stones are iron and out of whose hills thou mayest dig copper."

I have already suggested the huge amounts of copper used in the temple of Solomon. Copper utensils and mirrors were also employed in the homes of the wealthy. Copper was used decoratively and protectively on armor, weapons, and chariots. Solomon controlled extensive copper mines at Ezion-Geber. For many years archeologists sought to find the ancient site of Solomon's "Pittsburgh," now known in modern terms as Tell Kheleifah, which is at the head of the Gulf of Aquabah. It was located there for three reasons: first, there was a tremendous draft from the right direction up the Wadi Arabah to run the blast furnaces; second, there were plentiful wells of fresh water; and third, there were date palms for food. At a very early stage of the game these copper mines were under development, and in Solomon's time they were by all odds the greatest single source of his wealth. Equally important products of the copper mines and of the smelting furnaces of Solomon were the six-foot copper saws used to cut some of the huge blocks of stone in the building of the temple.

Copper and iron

In addition to the copper mines at the head of the Gulf of Aquabah, there were the iron mines of Philistia. The Philistines had a monopoly, a stranglehold on the iron mines. Those valuable mines were not located in Israel proper in the days of King Saul. Iron, prior to David's day, was a strictly limited article of supply in Israel. We read that Saul, the first King of Israel, and Jonathan, his son had swords and spears and metal armor, but such equipment was possessed only by a king and a prince, not by the common warrior at all.

You will recall that Saul tried to get David to put on his armor and use his sword when he went out against Goliath. David wisely preferred to fall back upon the simple instrument of destruction with which he was skilled. But it was not a mistake that Goliath of Gath, champion of the Philistines, would have had a full suit of armor and a sword and a spear of iron. He lived in the iron-mining country where all men were thus equipped. In David's boyhood, such farmers in Israel as had the best plowshares made of iron had to take them, or their colters or mattocks, to Philistia to be sharpened. It was no wonder that Israel wanted more than anything else to wrest the iron mines from the control of the Philistines. And when

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David finally reduced Philistia, this was an occasion for proper thanksgiving and rejoicing.

VI. *Irrigation Works*

The Panama Canal is modern wonder number six. Although there is nothing like it in the Bible, the irrigation canals in ancient Canaan were as important to the economy of that day and time. For instance, there was the gigantic Nahrwan Canal of Sargon's time, 400 feet wide, 15 feet deep, 250 miles long, paralleling the left bank of the Tigris River and irrigating an area of an average width of 18 miles!

Egypt, too, had her great canals. Thousands of years ago the Egyptians built a canal detouring the first Cataract of the Nile and opening it throughout its length for shipping. Thousands of years ago they dug a canal connecting the Mediterranean and the Red Sea which, fallen into disrepair through warfare, was reopened by Egypt's conqueror, Darius the Great. It was enlarged to 200 feet in width, 40 feet in depth, and used for more than a thousand years.

But nothing was more needed or more important to an agricultural economy than the irrigation canals in the central Negev of ancient Israel. Because of this series of dams and canals, there flourished an agriculture from the second century B.C. until the seventh century A.D. which made the desert blossom "as the rose," and which modern Israel is now beginning to duplicate.

The irrigation system of such canals was a necessity in an area where the annual rainfall was four inches — which usually fell in a 15-day period. The Israelites conserved this limited annual rainfall by the construction of low rubble masonry dams and cleverly contrived canals, indicating an observation of contour and an ingenuity of surveying that is truly miraculous. In one 50-square-mile area the ruins of 17,000 such dam-canal systems have been uncovered. These dams averaged 100-150 feet in length and between 5 and 6 feet in height. The result was a desert that *did* blossom as the rose and produced barley, wheat, legumes, dates, figs, and grapes, and supported at the height of this agricultural period six cities of between 3,000 and 6,000 population — all on four inches of rainfall a year!

VII. *Wells*

Number seven on the list of modern wonders is the San Francisco-Oakland Bay Bridge. The Bible can offer nothing comparable because bridges were non-existent in Biblical times. People simply got their feet wet or learned to swim! But we can comment on some of the spectacular wells built in those times.

First, there is Joseph's well at Cairo, which bears the name of a famous Biblical character but is not

mentioned in the Bible. It was 297 feet deep, all through solid rock. The upper course went down 165 feet deep with an oblong square of 18 by 24 feet; the remaining course went down the remaining 132 feet with a narrowed dimension of 9 by 15 feet. The access to the first level was by stairs cut out of the solid rock, and at that first level mules were used to operate an endless bucket chain which actually raised the water from the lower level to the first level.

Then there is Jacob's well, in the village of Sychar in Samaria, which is mentioned in both the Old and the New Testament. This was a relatively small engineering feat, but even so it was 9 feet in diameter. Originally it was 105 feet deep, until partial rubble filled it up so that it was only 75 feet deep in 1843. The last several feet of this well had been projected through solid limestone.

The water of life

While there are many references to wells in the Bible, there are only four wells mentioned by name. One of them is Jacob's well. Another is the well Abraham dug when he first got to the Promised Land, called the well of Beersheba. A third was the well of Bahurim, which has its claim to fame in Biblical history because it was in this well that two of the couriers of David hid from the wrath of Absalom, who, at that time, was trying to overthrow his father in an abortive revolutionary movement. The fourth was the well of Bethlehem. When David was in hiding from the Philistines and also from Saul, he expressed the longing to have "but a drink of the water from the well of Bethlehem," and three of his bodyguards risked their lives to pierce the enemy lines and get this drink for him.

It was at Jacob's well that Jesus held his historic conversation with the woman of Samaria which is preserved for us in one of the most moving and beautiful passages in the Gospel of John. Jesus had been left at the wellside to rest while his disciples went into the little village of Sychar to get something to eat, and while he was there a woman from Samaria (the Jews had no dealings with the Samaritans at all) came to the well to draw water. It would have been unthinkable for a man and a Jew to have asked such a woman for a drink of water, but Jesus did.

There ensues a colloquy which I am sure is familiar to many. Jesus begins to speak to her of "the water of life," and says that if she could come in contact with this water of life, she would not need to come hither again to draw. She replies, "The well is deep and thou hast nothing with which to draw." To find the answer to this problem after the flesh has throughout all the ages been the task of civil engineers who have devised tunnels, aqueducts, wells, canals, and dams.