ROADS AND CANALS OF ANCIENT WORLD.

ROADS

From the earliest times, one of the strongest indicators of a society's level of development has been its road system-or lack of one. Increasing populations and the advent of towns and cities brought with it the need for communication and commerce between those growing population centers. A road built in Egypt by the Pharaoh Cheops around 2500 BC is believed to be the earliest paved road on record-a construction road 1,000 yards long and 60 feet wide that led to the site of the Great Pyramid. Since it was used only for this one job and was never used for travel, Cheops's road was not truly a road in the same sense that the later trade routes, royal highways, and impressively paved Roman roads were.

The various trade routes, of course, developed where goods were transported from their source to a market outlet and were often named after the goods which traveled upon them. For example, the Amber Route traveled from Afghanistan through Persia and Arabia to Egypt, and the Silk Route stretched 8,000 miles from China, across Asia, and then through Spain to the Atlantic Ocean. However, carrying bulky goods with slow animals over rough, unpaved roads was a time consuming and expensive proposition. As a general rule, the price of the goods doubled for every 100 miles they had to travel.

Some other ancient roads were established by rulers and their armies. The Old Testament contains references to ancient roads like the King's Highway, dating back to 2000 BC. This was a major route from Damascus in Palestine, and ran south to the Gulf of Aqaba, through Syria to Mesopotamia, and finally on to Egypt. Later it was renamed Trajan's Road by the Romans, and was used in the eleventh and twelfth centuries by the Crusaders when they attempted to "reclaim" the Holy Land. Around 1115 BC the Assyrian Empire in western Asia began what is believed to be the first organized road-building, and continued it for 500 to 600 years. Since they were trying to dominate that part of the world, they had to be able to move their armies effectively-along with supplies and equipment. Their army's engineer corps laid pontoon bridges and leveled tracks for carts and siege engines. As the Assyrians gradually faded, another imperial road, the Royal Road, was being built by the Persians from the Persian Gulf to the Aegean Sea, a distance of 1,775 miles. Around 800 BC, Carthage, on the northern coast of Africa, began to use stones for paving roads.

Although they may not have been the first to pave their roads with stones, they were among the earliest, and some people believe that the Romans imitated Carthaginian techniques.

Without doubt, the champion road builders of them all were the ancient Romans, who, until modern times, built the world's straightest, best engineered, and most complex network of roads in the world. At their height, the Roman Empire maintained 53,000 miles of roads, which covered all of England to the north, most of Western Europe, radiated throughout the Iberian Peninsula, and encircled and crisscrossed the entire Mediterranean area. Famous for their straightness, Roman roads were composed of a graded soil foundation topped by four courses: a bedding of sand or mortar; rows of large, flat stones; a thin layer of gravel mixed with lime; and a thin surface of flint-like lava. Typically they were 3 to 5 feet thick and varied in width from 8 to 35 feet, although the average width for the main roads was from 12 to 24 feet. Their design remained the most sophisticated until the advent of modern road-building technology in the very late 18th and 19th centuries. Many of their original roads are still in use today, although they have been resurfaced numerous times.

Under Roman law, the public had the right to use the roads, but the district through which a road passed was responsible for the maintenance of the roadway. This system was effective so long as a strong central authority existed to enforce it. Unfortunately, as the Roman Empire declined so did their roads, and their work fell into disrepair all across Europe and Great Britain.

On the other side of the Atlantic Ocean, several centuries after the fall of the Roman Empire, the Inca Empire began to rise in South America during a period that corresponded with the middle Ages in Europe. Centered in what is now Peru, the Incas branched out into Ecuador, Colombia, Bolivia, Argentina, and Chile, and, like the Romans, recognized the need for a system of roads that would enable them to extend their conquests and to govern their empire. Interestingly enough, the Incas built their empire without inventing the wheel, without the use of draft animals, and without a written language. Because they had no wheeled vehicles to worry about, their roads could ascend steep inclines via terraces or steps-in one place a road going up a steep mountainside was built of 3,000 consecutive stone steps. They also built over swamps, and constructed a causeway 24 feet wide and 8 miles long, which had a paved surface and stone walls. Unfortunately,

their well-constructed system of roads ultimately assisted in their downfall as the invading Spaniards used the Incas' own roads to move Spanish armies, weapons, and supplies.

Back across the Atlantic, but later, in 18th century England, the technology of highway construction was getting a long overdue boost from two British engineers, Thomas Telford and John Loudon McAdam. Telford, originally a stonemason, came up with a system of road building which required digging a trench, installing a foundation of heavy rock, and then surfacing with a 6-inch layer of gravel. During construction, the center of the road was raised, producing a crown that allowed water to drain off. In the course of his career, Telford built over 1,000 roads, 1,200 bridges, and numerous other structures. Although his system was faster and less expensive that the Romans' method, it was still costly and required frequent resurfacing with gravel.

On the other hand, McAdam's system was based on the principle that a well-drained road made of suitable material does not need the stone foundation of Telford's system, but could be built directly on the subsoil. First McAdam placed a closely compacted 10- to 12-inch layer of stone which had been broken to an inch in diameter, and which was raised in the center to facilitate drainage. This was followed by a carpet of finer grained stone that was cemented by the setting of the powder, a process that was completed in stages, allowing the road's traffic to compact each stage. The greatest advantages to McAdam's system were its speed and low cost, and it was generally adopted throughout Europe. However, it was the lack of a firm foundation for the roadbed that was to prove the ultimate undoing of macadam roads with the advent of heavy motor vehicles, especially trucks. For that reason, on roads that had to support heavy loads, Telford's system of construction became the standard.

During this same time period, the growth of turnpikes was resulting in much improved road conditions across England. Private individuals built roads themselves and then charged for their use, usually blocking passage by setting a long pole (pike) across the road. Once the toll had been paid, the pole would be swung (turned) out of the way, allowing the travelers access to the road (turnpike). By 1829, 3,783 different turnpike companies operated 20,000 miles of highway throughout England. However, during the latter half of the 19th century, canal building and the

growth of railroads outstripped the turnpikes, and roads in general became less important until the turn of the century.

As European settlers migrated across the Atlantic to the U.S., they found themselves faced with an almost total lack of roads-in Europe they had at least had the Roman roads to use as a foundation for rebuilding. In America there were only Indian trails, and while they were long and quite extensive, they were also very narrow, allowing only for single file passage of foot traffic. Like their Inca counterparts, the natives of North America did not invent a wheel, and so did not develop roads that would accommodate wheeled vehicles. Initially, America's early roads were no more than widened Indian trails which had been leveled and filled, most of them full of tree stumps that tripped horses and halted wagons. The expression, "I'm stumped," derived from this era, when vehicles were frequently hung up on tree stumps and could go no further until they'd been freed. Also, since most of these early roads ran through forests, the route was often marked by notches chopped on trees, from which evolved names like "Three Notch Road." America, like England, went through a period of turnpike development, and for many years, turnpikes were the best roads in the U.S.

Not surprisingly, the overall development of transportation in the U.S. continued to parallel its counterpart in England, and interest in building and maintaining long distance roads waned during the last half of the 19th century. As in England, this was due both to increased canal building and the growth of railroads. But the advent of the motorcar changed all that for everyone, and the advent of the motor truck changed it even more. Obviously, motorized vehicles made it possible for both people and goods to travel both more quickly and more comfortably-so long as there were adequate roads upon which they could travel. Thus the Good Roads Movement was born.

Before proceeding with motor vehicles, we have to give some credit to bicycles for bringing attention to the need for good roads, since these two-wheeled vehicles enjoyed enormous popularity in the late 19th century. Many clubs and cycling societies sprang up, including the League of American Wheelmen, a national organization founded in 1880 whose members began crying out for better roads. The first definite success of the fledgling Good Roads Movement was achieved in 1891, when New Jersey became the first state to take responsibility at the state level

for improving roads and formed a State Highway Department. Massachusetts followed this example in 1892, and by 1917 all the states had adopted similar programs.

However, aside from outspoken cyclists and their leisure time needs, farmers were actually the earliest commercial agitators for the Good Roads Movement, since they needed a way to get their farm products to market. In addition, the railroads initially supported early efforts to improve local roads for farmers because it increased their own traffic. In 1896, the Department of Agriculture opened an Office of Road Inquiry to assist in the development of better roads, and an often-heard slogan was, "Get the farmer out of the mud!" Of course, once it became clear that motor trucks presented a serious competitive threat to their business, the railroads began losing their enthusiasm for the Good Roads Movement.

U.S. Senator John H. Bankhead* (see endnote), of Jasper, AL, was president of the Good Roads Association, and played a key role in funding the nation's road-building efforts. As Chairman of the Senate Committee on Post Offices and Post Roads, he introduced bills that appropriated money for the construction of post roads. In 1912, he pushed through a $500,000 appropriation that resulted in 425 miles of improved roads in 17 states. Then in 1916 Sen. Bankhead got the Federal Highway Act passed, which has been the basis for a continuing federal aid road building program ever since. These early programs led to both the Highway Trust Fund which was implemented in 1956 in order to construct our interstate highway system, and the Federal-Aid Highway Act of 1968, which modified and expanded the interstate system.

As they say, the rest is history-a history that most of us have experienced-and just about any drive we take today provides concrete evidence of the outcome. Ironically, even at its height, our modern interstate highway system totals only about 42,500 miles (as of 1991). Granted, this figure does not include surface streets or other roads. But 2,000 years ago the Romans, without the help of all our engineering technology or road-building machinery, constructed 53,000 miles of roads, much of which is still in use today.

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The Story of the Road, by J. W. Gregory; American Highways, by Victoria Faber Stevenson; The Congressional Record; and Debra West, Librarian, Auburn University at Montgomery, AL.-SSS

ROMAN ROADS: 2ND CENTURE BC – 2ND CENTURY AD

Roman roads were a vital part of the development of the Roman state, from about 500 BC through the expansion during the Roman Republic and the Roman Empire. Roman roads enabled the Romans to move armies and trade goods and to communicate.

The Roman road system spanned more than 400,000 km of roads, including over 80,500 km of paved roads. When Rome reached the height of its power, no fewer than 29 great military highways radiated from the city. Hills were cut through and deep ravines filled in.

At one point, the Roman Empire was divided into 113 provinces traversed by 372 great road links. In Gaul alone, no less than 21,000 km of road are said to have been improved, and in Britain at least 4,000 km. There were footpaths on each side of the road.

The Romans became adept at constructing roads, which they called viae. They were intended for carrying material from one location to another. It was permitted to walk or pass and drive cattle, vehicles, or traffic of any description along the path. The viae differed from the many other smaller or rougher roads, bridle-paths, drifts, and tracks. To make the roads the Romans used stones, broken stones mixed with cement and sand, cement mixed with broken tiles, curving stones - so the water could drain, and on the top they used tightly packed paving stones.

The Roman road networks were important both in maintaining the stability of the empire and for its expansion. The legions made good time on them, and some are still used millennia later. In later antiquity, these roads played an important part in Roman military reverses by offering avenues of invasion to the barbarians.

The great network of roman roads, the arterial system of the empire is constructed largely by the solders of the legions, often with the assistance of prisoners of war or slave labor. The amount of labor involved is vast for these highways are elaborate technological undertakings.

The average width of a roman road is about 10 yards. Below the paved surface the fabric extends to a depth of 04 or 05 feet in a succession of carefully constructed layers. Then four successive layers are constructed, each a foot or more thick. Part of the purpose of roman roads is speed of communication, so there are post houses with fresh horses every 10 miles along the route and lodging for travelers every 25 miles.

By the 2nd century AD the network spreads all around the Mediterranean and throughout Europe up to the Danube, the Rhine and northern England, amounting in all too some 50,000 miles. This for outdoes even the very impressive achievement of the Persian network roads. Travelers on foot or horseback have rarely been so well provided for.

For haulage purposes these roads are less satisfactory, because the straight line results in some very steep hills. Anyone with a wagon and horse would prefer an altitude less serve than that of roman need engineer.

INCA ROAD SYSTEM: 15TH CENTURY AD

The Inca civilization flourished in ancient Peru between c. 1400 and 1533 CE, and their empire eventually extended across western South America from Quito in the north to Santiago in the south, making it the largest empire ever seen in the Americas and the largest in the world at that time.

The Inca road system formed a network known as the royal highway, which became an invaluable part of the Inca Empire, not only facilitating the movement of armies, people, and goods but also providing an important physical symbol of imperial control. Across plains, deserts, and mountains, the network connected settlements and administrative centers. Well-built and lasting, many roads included bridges, causeways, stairways, and also had small stations (chaskiwasi) and sometimes larger, more luxurious complexes (tambos) dotted along every 20 km or so, where travellers could

spend the night and refresh. The Andean road system is listed by UNESCO as a World Heritage Site.

Inca roads covered over 40,000 km (25,000 miles), principally in two main highways running north to south across the Inca Empire, which eventually spread over ancient Peru, Ecuador, Chile, Bolivia, and Argentina. One highway ran down the coast, and the other wound through the highlands. Another important route ran east from Quito (Ecuador) across to Mendoza (Argentina), and there was also a major route along the plains of the northern coast. Criss-crossing these main roads were some 20 other secondary routes and many smaller trails besides. Roads were also built which went beyond Inca-controlled settlements and led to outside territory, perhaps to facilitate trade with, or military operations against, neighboring peoples. Along some of the more important highways, milestones marked each Inca unit of distance, the topo, equivalent to 7 km.

ROADS OF ANCIENT INDIA

The history of the development of road construction is linked with the history of human civilization. The first and oldest mode of travel was footpath with people found the most convenient and the shortest way to approach to their hunting and fishing ground. People use tamed animals for transport which required bridle paths of greater width and heights. After the invention of the wheel, animal-drawn carts continued to be the popular mode of transport for quite a long time. This had necessitated providing hard surfaces for wheeled carts. The first hard surface was discovered in Mesopotamia at about 3500 B.C.

The excavations of Mohenjodaro and Harappa have established the existence of roads in India at about 3500 B.C. As per the early records, in early periods the roads were mainly for administrative and military purposes. During Aryan period in 400 B.C., there were “Mahapathas” as a means of communications as referred in Rig Veda (part 1, para 5). Kautilya the first Prime Minister of Emperor Chandragupta Maurya laid down rules in his book titled Arthasastra. Rules have been mentioned regarding the depth of roads for various purposes and for different types of traffic. The punishment for obstructing roads have also been mentioned. At the beginning of 5th century, the roads had been improved by Emperor Ashoka.

Roads in Mughal period:

The roads were greatly improved in India during the Mughal period. Many of the highway built or maintained by Mughals received great appreciation from the foreign visitors. The road from Delhi to Daulatabad was constructed by Muhammad Tughlaq. The roads from Agra to Allahabad and from Ujjain to Bijapur were constructed by Muslim emperor.

Roads in British period:

The period covering the decision the decline of the Mughals and the beginning of the British rule was a period of neglect of the road system. During this period, the condition of roads deteriorated. The early British interest was only in maintaining roads of military importance. William Bentinck took steps to build the modern Grand Trunk Road from Calcutta to Delhi with permanent bridges and good stones. Lord Dalhousie gave further Momentum to road construction by forming the P.W.D in place the military board in 1885. With the development of Railways, the attention of the government was shifted from road development. The work of road construction and maintenance was given secondary importance. Major Roads, except those of military importance, were neglected and attention was mainly on the feeder Roads.

CANALS

THE GREAT CANAL OF DARIUS 1: 6TH CENTURY CE

Darius I, the Great, was the tenth king of the Achaemenian dynasty (c700-330 BCE), which had early in its history, established two royal lines that stemmed from the second king, Chishpish's (Teispes') two son's, Kurush I (Cyrus I - not to be confused with Cyrus the Great) and Arshama (Arsames). Kurush (Cyrus) I established the first line that ended with Kurush (Cyrus) II with his murder by Bardia (Smerdis) the usurper. Darius, son of Vishtasp, governor of Persia, and grandson of Arshama (Arsames) who established the second line, reclaimed the Persian throne for the Achaemenians.

Darius commissioned the construction of a network of canals underground and waterways. This network served to meet the agricultural needs of farmers, as well as the water supply needs of

towns and cities. The canals connected to rivers were integrated into the transportation system that ran from the heartland to the sea.

Suez Canal

The cutting of canal for irrigation purpose has been an essential part of Mesopotamia, controlling the water of the Euphrates and the Tigris. Several canal link the two rivers, and small boats use these waterways. But the world's first canal created purely for water transport is an incomparably more ambitious affair.

In 1866, by Charles de Lesseps, Ferdinand de Lesseps's son, discovered near Kabret, a town some 130 kilometres form Suez, a stele of pink granite which contained an inscription engraved by Darius. The stele which is also known as the Chalouf Stele (alt. Shaluf Stele) states:

"Says King Darius: I am a Persian. Setting out from Persia, I conquered Egypt. I ordered to dig this canal from the river called the Nile that flows through Egypt, to the sea that begins in Persia. Therefore, when this canal had been dug as I had ordered, ships could sail through this canal from Egypt to Persia, as I had intended."

To open the canal, Darius traveled to Egypt in 497 BCE, where he inaugurated the canal amid much fanfare and festivities. Darius' Suez Canal, which ran from modern Zaqaziq to modern Suez, appears to have stayed in use for over 200 years after its construction. However, by the time of Cleopatra it filled with sand, silt and debris and fell into disuse. The Roman Emperor Trajan repaired and cleaned out the canal and put it back to use. By the time the Arab Amr ibn el-As conquered Egypt, however, the canal had fallen into disrepair again.

The canal passed through Wadi Tumilat, and connected the easternmost branch of the Nile River, the Bubastite, with Lake Timsah which was connected to the Red Sea by natural waterways.

According to Herodotus, Histories, 2.158, "...the canal to the Red Sea ...the length of which is four days' journey, and the width such as to admit of two triremes being rowed along it abreast. The water is derived from the Nile, which the canal leaves a little above the city of Bubastis, near

Patumus, the Arabian town, being continued thence until it joins the Red Sea. At first it is carried along the Arabian side of the Egyptian plain, as far as the chain of hills opposite Memphis, whereby the plain is bounded, and in which lie the great stone quarries; here it skirts the base of the hills running in a direction from west to east, after which it turns and enters a narrow pass, trending southwards from this point until it enters the Arabian Gulf. From the northern sea to that which is called the southern or Erythraean, the shortest and quickest passage, which is from Mount Casius, the boundary between Egypt and Syria, to the Gulf of Arabia, is a distance of exactly one thousand furlongs. But the way by the canal is very much longer on account of the crookedness of its course."

THE GRAND CANAL: 3RD CENTURY BC – 13TH CENTURY AD

The Grand Canal is a man-made waterway that runs north and south in eastern China. It is the longest man-made waterway in the world.

How long is it? The canal stretches over 1,100 miles from the city of Beijing to the city of Hangzhou. It is sometimes called the Beijing-Hangzhou Canal. Besides connecting these two major cities, the canal also connects the two major rivers of China: the Yellow River and the Yangtze River.

Why was the Grand Canal built? The canal was built in order to easily ship grain from the rich farmland in southern China to the capital city in Beijing. This also helped the emperors to feed the soldiers guarding the northern borders.

Early Canals

The Ancient Chinese built early canals to help with transportation and commerce. One early section was the Han Gou Canal built by Kin Fuchai of Wu around 480 BC. This canal stretched from the Yangtze River to the Huai River. Another ancient canal was the Hong Gou Canal which went from the Yellow River to the Bian River. These ancient canals became the basis for the Grand Canal over 1000 years later.

Building the Grand Canal

it was during the Sui Dynasty that the Grand Canal was built. Emperor Yang of the Sui wanted a quicker and more efficient way of transporting grain to his capital city at Beijing. He also needed to supply his army that guarded northern China from the Mongols. He decided to connect the existing canals and expand them to go all the way from Beijing to Hangzhou. Building the canal was a huge project. It took over six years of hard work by millions of laborers. Emperor Yang was a tyrant. He forced millions of farmers to work on the canal. Many of them died during the construction. However, when the canal was finally completed in 609 AD, China had a new waterway that would enrich the country for hundreds of years to come.

Later Improvements

The Ming Dynasty rebuilt much of the canal in the early 1400s. They made the canal deeper, built new canal locks, and constructed reservoirs to regulate the water in the canal. The main purpose of the canal continued to be the transport of grain. This continued throughout the Ming Dynasty and most of the history of Ancient China.

Interesting Facts about the Grand Canal

- Historians estimate that the oldest section of the canal was built around the 6th century BC.
- Emperors would sometimes travel along the Grand Canal to inspect the locks.
- It is estimated that it took over 45,000 full-time laborers to maintain the canal during the Ming Dynasty.
- The canal was also used as a courier route for carrying important government messages.
- In the 1400s, the Chinese government operated over 11,000 grain barges on the canal to transport food to the north.
- The Grand Canal also proved to be an excellent source of taxes for the Chinese government.
- Portions of the canal fell into disrepair after the Yellow River flooded in 1855.
- The pound lock was invented during the Song Dynasty in 984 AD to help raise and lower the water level of the canal.

EUROPEAN CANAL: 12TH – 17TH CENTURY AD

In one area of Europe, the Netherlands canal building is an integral part of development. The primary purpose is drainage, an ancient transport network is a welcome bonus. But in Italy, in late 12th century, an ambitious canal was constructed without any subsidiary motive of drainage or even irrigation. It is the Naviglio Grande, built between 1179 and 1209 to bring marble from near lake maggiore for the construction of cathedral in Milan. The barges float down the river Ticino before diverting into the canal, which has a fall of 110 feet in its length of 31 miles. The next comparable project, a century later is a canal with a different purpose – to improve trade.

Stecknitz Canal

German Stecknitzfahrt, Europe's first summit-level canal (canal that connects two water-drainage regions), linking the Stecknitz River (a tributary of the Trave River) with the Delvenau River (a tributary of the Elbe River). The 11.5-km (7-mile) canal was built between 1390 and 1398 to enable water transport of salt from the Lüneburg region to Lübeck, capital of the Hanseatic League and an important trading centre on the Baltic Sea.

The Stecknitz River was made navigable about 1340 using flash locks, a primitive and dangerous type of lock that used boards, or paddles, supported by horizontal timbers, that could be removed to allow a temporary "flash" of water into a lock. In 1390 permission was granted for a canal to be built in order to connect the Stecknitz River to the Delvenau River and for the Delvenau to be made navigable down to the Elbe River. The waterway, which had a total length of 97 km (60 miles), opened in 1398. The canal was 16.6 metres (54 feet) above sea level. There were seven flash locks on the Delvenau, four on the canal section, and three on the Stecknitz.

The first boats carried about 7.5 tons on a draft of 0.5 metre (1.5 feet) and took a minimum of 10 days to traverse the waterway; much time was wasted in waiting for streams to replace the water used by the flash locks. About 10,000 tons were carried annually in the 16th century, when the waterway was rebuilt. It was rebuilt again in the 1820s, for boats carrying 37 tons, to dimensions of 23 metres (75 feet) long, 4.31 metres (14 feet) wide, and 0.7 metre (2.25 feet) deep. The waterway closed in 1893, much of its route being used by the new Elbe-Lübeck Canal.

Briare Canal

The Canal de Briare was the first major watershed canal to be built in Europe. It originally linked the river Loire at Briare to the river Loing at a point 5km north of Montargis. For centuries it was a lifeline for Paris, food and fuel (wood and coal) being brought to the capital by barge from the upper Loire and Allier valleys. When the Canal latéral à la Loire was enlarged (see historical note below), with its famous aqueduct crossing the Loire at Briare, the connection was made at La Cognardière, 2.6km and four locks from its junction with the Loire. The bypassed section of the canal was initially retained as a branch, then abandoned after commercial traffic ceased. It was restored in the 1980s to allow boats to lock down to the canal basin in the middle of the town, now one of the biggest and most popular ports de plaisance in France. The canal extends 57km from its connection with the Canal du Loing at Buges lock, north of Montargis, to the original lock down into the river Loire. Connection is made with the Canal latéral à la Loire at km 2.6 (La Cognardière, north of Briare). The canal is part of the 'Bourbonnais' route from Paris to Lyon.