Vol III Issue IX June 2014

ISSN No : 2249-894X

Monthly Multidisciplinary Research Journal

Review Of Research Journal

Welcome to Review Of Research

RNI MAHMUL/2011/38595 **ISSN No.2249-894X**

Review Of Research Journal is a multidisciplinary research journal, published monthly in English, Hindi & Marathi Language. All research papers submitted to the journal will be double - blind peer reviewed referred by members of the editorial Board readers will include investigator in universities, research institutes government and industry with research interest in the general subjects.

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Review Of Research
Vol. 3 | Issue. 9 | June. 2014
Impact Factor : 2.1002 (UIF)
ISSN:-2249-894X

Available online at www.ror.isrj.net

ORIGINAL ARTICLE

THE HISTORY OF TRANSPORTATION ENGINEERING

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Abstract:

Transportation engineering is the application of technology and scientific principles to the planning, functional design, operation and management of facilities for any mode of transportation in order to provide for the safe, efficient, rapid, comfortable, convenient, economical, and environmentally compatible movement of people and goods (transport). It is a sub-discipline of civil engineering and of industrial. Transportation engineering is a major component of the civil engineering and mechanical engineering disciplines, according to specialization of academic courses and main competences of the involved territory.

The planning aspects of transport engineering relate to urban planning, and involve technical forecasting decisions and political factors. Technical forecasting of passenger travel usually involves an urban transportation planning model, requiring the estimation of trip generation (how many trips for what purpose), trip distribution (destination choice, where is the traveler going), mode choice (what mode is being taken), and route assignment (which streets or routes are being used). More sophisticated forecasting can include other aspects of traveler decisions, including auto ownership, trip chaining (the decision to link individual trips together in a tour) and the choice of residential or business location (known as land use forecasting). Passenger trips are the focus of transport engineering because they often represent the peak of demand on any transportation system.

The first form of transport was, of course, Shanks pony (the human foot!). However people eventually learned to use animals for transport. Donkeys and horses were probably domesticated between 4,000 and 3,000 BC (obviously the exact date is not known). Camels were domesticated slightly later between 3,000 and 2,000 BC. Meanwhile about 3,500 BC the wheel was invented in what is now Iraq. At first wheels were made of solid pieces of wood lashed together to form a circle but after 2,000 BC they were made with spokes. The earliest boats were dugout canoes. People lit a fire on a big log then put it out and dug out the burned wood. About 3,100 BC the Egyptians invented the sailing boat. They were made of bundles of papyrus reeds tied together. They had simple square sails made of sheets of papyrus or later of linen. However the sail could only be used when sailing in one direction. When travelling against the wind the boat had to be rowed. About 2,700 BC the Egyptians began using wooden ships for trade by sea. Early ships were steered by a long oar. Modern transportation system including railway, roadway, airway, etc. Now a day's our transportation not only limited only limited within the earth. What will be the next mission of transportation system??

KEYWORDS:

First vehicle, Early road transport, Development of water way, Railway, Modern highway &

Title: "THE HISTORY OF TRANSPORTATION ENGINEERING " , Source: Review of Research [2249-894X] Dipanjan Mukherjee yr:2014 | vol:3 | iss:9

railway in INDIA, Tacking flight, Beyond the earth.

1.INTRODUCTION

The early man generally walked, dragged, rolled or pushes, what he or she needed to transport, some time they were alone or in a group. Early road were “worn” path. But today's life transportation has been one of the essential components of our life. Although it has been one of the essential part of civil engineering profession since its early days. From time immemorial, the building of roads, bridges, pipelines, tunnels, canals, railroads, ports, and harbors has shaped the profession and defined much of its public image. As cities grew, civil engineers became involved in developing, building, and operating transit facilities, including street railways and elevated and underground systems. The role of civil engineers in providing transportation infrastructure to accommodate a growing population and economy was never more prominent than in the United States around the late 19th century and the early part of the 20th century. Transcontinental railroads, national highways, canals, doc harbor, air port as well as major urban transit systems, are testimonials to the achievement of civil engineers & transportation engineers. And, in the latter part of the last century, these achievements played a major role in developing the Interstate System, new rail transit lines, and major airports etc.

2. FIRST VEHICLE PALKI:-

The Duli and Palki was a type of legendary vehicle of ancient India. They belong to a class of wheel less human-powered transport. During medieval India Palki were used as most essential wedding transportation means. Brides were carried to the bridegrooms' places by palki.

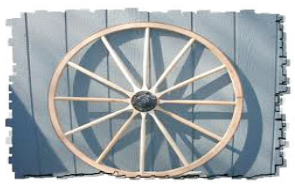

Figure Palki & Wheel

3. THE DEVELOPMENT OF WHEEL: -

The development of wheel leads to the development of wheeled vehicle. The wheel is one of the main components of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel, potter's wheel and flywheel. Common examples are found in transport applications. A wheel greatly reduces friction by facilitating motion by rolling together with the use of axles. In order for wheels to rotate, a moment needs to be applied to the wheel about its axis, either by way of gravity, or by the application of another external force or torque. The oldest securely dated wheel-axle combination, that from Stare Gmajne near Ljubljana in Slovenia (Ljubljana Marshes Wooden Wheel) is now 3340-3030 cal BC, the axle to 3360-3045 cal BC .The earliest well-dated depiction of a wheeled vehicle (here a wagon—four wheels, two axles) is on the Bronocice pot, a c. 3500 – 3350 BC clay pot excavated in a Funnel beaker culture settlement in southern Poland. The wheeled vehicle spread from the area of its first occurrence (Mesopotamia, Caucasus, Balkans, and Central Europe) across Eurasia, reaching the Indus Valley by the 3rd millennium BC. During the 2nd millennium BC, the spoke-wheeled chariot spread at an increased pace, reaching both China and Scandinavia by 1200 BC. In China, the wheel was certainly present with the adoption of the chariot in c. 1200 BC.

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4. FIRST ROAD: -

Wheels appear to have been developed in ancient Sumer in Mesopotamia around 5000 BC, perhaps originally for the making of pottery. Their original transport use may have been as attachments to travois or sleds to reduce resistance. It has been argued that logs were used as rollers under sleds prior to the development of wheels, but there is no archeological evidence for this. Most early wheels appear to have been attached to fixed axles, which would have required regular lubrication by animal fats or vegetable oils or separation by leather to be effective. The first simple two-wheel carts, apparently developed from travois, appear to have been used in Mesopotamia and northern Iran in about 3000 BC and two-wheel chariots appeared in about 2800 BC. They were hauled by onagers, related to donkeys. Heavy four-wheeled wagons developed about 2500 BC, which were only suitable for oxen-haulage, and therefore were only used where crops were cultivated, particularly Mesopotamia. Two-wheeled chariots with spoked wheels appear to have been developed around 2000 BC by the Andronovo culture in southern Siberia and Central Asia. At much the same time the first primitive harness enabling horse-haulage was invented. Wheeled-transport created the need for better roads. Generally natural materials cannot be both soft enough to form well-graded surfaces and strong enough to bear wheeled vehicles, especially when wet, and stay intact. In urban areas it began to be worthwhile to build stone-paved streets and, in fact, the first paved streets appear to have been built in Ur in 4000 BC.Corduroy roads were built in Glastonbury, England in 3300 BC and brick-paved roads were built in the Indus Valley Civilization on the Indian subcontinent from around the same time. Improvements in metallurgy meant that by 2000 BC stone-cutting tools were generally available in the Middle East and Greece allowing local streets to be paved. Notably, in about 2000 BC, the Minoans built a 50 km paved road from Knossos in north Crete through the mountains to Gortyn and Lebena, a port on the south coast of the island, which had side drains, a 200 mm thick pavement of sandstone blocks bound with clay-gypsum mortar, covered by a layer of basaltic flagstones and had separate shoulders. This road could be considered superior to any Roman road. In 500 BC, Darius I the Great started an extensive road system for Persia (Iran), including the famous Royal Road which was one of the finest highways of its time. The road was used even after the Roman times. Because of the road's superior quality, mail couriers could travel 2,699 kilometres (1,677 mi) in seven days.

4.1 In India:-

The first evidence of road development in the Indian subcontinent can be traced back to approximately 4000 BC from the ancient cities of Harrapa and Mohenjodaro of the Indus Valley Civilization. Ruling emperors and monarchs of ancient India had constructed numerous brick roads in the cities. One of the most famous highways of medieval India is the Grand Trunk Road. The Grand Trunk Road built by Sher shah suri 1540 to 1545, began in Sonargaon near Dhaka in Bangladesh and ended at Peshawar in modern-day Pakistan. In India, it linked several important cities from Kolkata in the east to Amritsar in the west, while passing through the cities of Patna, Varanasi, Kanpur, Agra, Delhi, Panipat, Pipli, Ambala, Rajpura, Ludhiana, and Jalandhar. Locally called the GT Road, the Grand Trunk Road, was the road used by Brigadier General John Nicholson of the British Empire to quickly move his troops, hundreds of miles, to Delhi in 1857. This road allowed him to lead the battle that ended the Indian Mutiny of 1857.

By Indian independence in 1947, India inherited a poor road network infrastructure. Between 1947 and 1988, India witnessed no new major projects, poor maintenance. Predominantly all roads were single lane, most unpaved. India had no expressways, and less than 200 kilometres of 4-lane highways. In 1988, the National Highways Authority of India was established in India by an Act of Parliament. This autonomous entity came into existence on 15 June 1989. The Act empowered this entity to develop, maintain and manage India' road network through National Highways. However, even though the Authority was created in 1988, not much happened till India introduced widespread economic

liberalisation of the early 1990s. Since 1995, the authority has privatised road network development in India, and delivered by December 2011, over 70,000 kilometres of National Highways, of which 16,500 kilometres are 4-lane or 6-lane modern highways.

5. THE EARLY TRANSPORTATION SYSTEM:-

Around 3000 BC early transportation system were three types,

1.Uses of domestic animals
2.Wheeled vehicle
3.Sail the ship

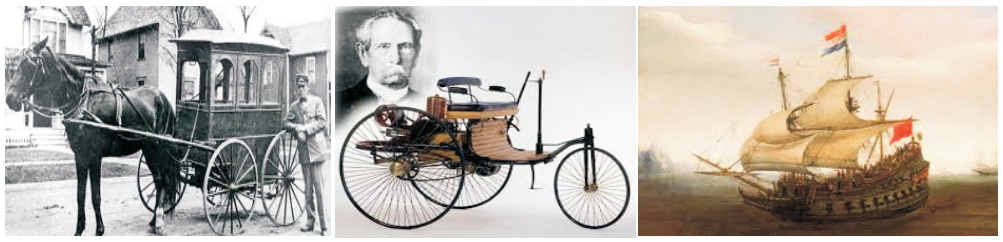


Figure Early transportation system

6. EARLY PAVEMENT TECHNOLOGY: -

(Roman pavement technology) Roman roads (in Latin, viae - singular via) were vital to the maintenance and development of the Roman state, and were built from about 500 BC through the expansion and consolidation of the Roman Republic and the Roman Empire. They provided efficient means for the overland movement of armies, officials and civilians, and the inland carriage of official communications and tradegoods. Roman roads were of several kinds, ranging from small local roads to broad, long-distance highways built to connect cities, major towns and military bases. These major roads were often stone-paved and metaled, cambered for drainage, and were flanked by footpaths, bridleways and drainage ditches. They were laid along accurately surveyed courses, and some were cut through hills, or conducted over rivers and ravines on bridgework. Sections could be supported over marshy ground on rafted or piled foundations.

At the peak of Rome's development, no fewer than 29 great military highways radiated from the capital, and the Late Empire's 113 provinces were interconnected by 372 great road links. The whole comprised more than 400,000 km of roads, of which over 80,500 kilometres (50,000 mi) were stone-paved. In Gaul alone, no less than 21,000 kilometres (13,000 mi) of road are said to have been improved, and in Britain at least 4,000 kilometres (2,500 mi). The courses, and sometimes the surfaces of many Roman roads survived for millennia. Some are overlaid by modern roads.

As is the case today, Roman roads developed an economy of their own. A network of both public sector and private sector wayside resting houses developed. The public sector resting houses generally served military and official travellers whilst the private sector ministered to the needs of the general public. Blacksmiths, Horse Renters and Traders also derived a living from the travellers on the roadll . Pliney the elder, voiced the feelings of many when he said:

"Which way was vice introduced if it was not by the public
road? Which other way indeed could ivory, gold and precious
stones have passed into private use?"

Clearly the road was very much a reflection of the society which it served and it may be no exaggeration to state that the Roman empire was a network of roads linking together many disparate peoples and cultures. It is also considered that the expansion of Christianity was dependent upon the network of Roman roads which had reached Jerusalem by the time of the birth of Christ.

The level of industry associated with the Roman roads can be gauged by considering the rich variety of vehicles which were available. Horses, mules and donkeys were used as pack animals and to pull carts. Many of the carts used by the Romans were introduced when they conquered Gaul (France) and the following varieties were in common use:

benna - a light cart constructed to carry several passengers;
carpentum - a two-wheeled covered gig used by women;
carrus- a luxury chariot often used by officials, the forerunner of today's saloon car;
rhedda - a four-wheeled cart used by the Roman Imperial Post to transport the mail;
plaustrum – a two-wheeled cart used by farmers to transport their crops;
sartacum - a four-wheeled cart with solid wheels and a low bed used for transporting timber (the Roman low loader).

Roman literature deals only rarely with road construction since Roman writers were more concerned with politics and culture than they were with engineering. However, there are some notable exceptions which provide an insight into the Romans' views on their roads. There are several words used to describe different types of roads and different parts of roads,

as followsll :

via- a carriageway permitting two vehicles to pass;
vicus- a city street;
actus- a single lane road 1.2m wide, originally used for driving animals;
agger- an embankment upon which a pavement is built;
amnbulation- a pedestrian town street;
clivus- a cul-de-sac
fundula- a street on a hill;
pervium - a town street;

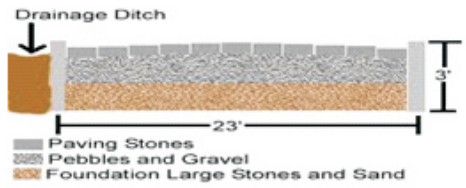


Figure 3 Roman pavement technology

7 MAGNETIC COMPASS INNOVATION:-

Eventually someone noticed that the lodestones were better at pointing out real directions, leading to the first compasses. They designed the compass on a square slab which had markings for the cardinal points and the constellations. The pointing needle was a lodestone spoon-shaped device, with a handle that would always point south. Magnetized Needles - Magnetized needles used as direction pointers instead of the spoon-shaped lodestones appeared in the 8th century AD, again in China, and between 850 and 1050 they seem to have become common as navigational devices on ships. Compass as a Navigational Aid - The first person recorded to have used the compass as a navigational aid was Zheng He (1371-1435), from the Yunnan province in China, who made seven ocean voyages between 1405 and 1433.

7.1 Notable voyages:-

1942 Christopher Columbus discover Americas.
1947-8 Vasco de Gama sail around Africa.
1519-22 Ferdinand Magellan fiat voyages around the world.

8. MACADAM PAVEMENT CONSTRUCTION: -

macadam, form of pavement invented by John Macadam of Scotland in the 18th century. Macadam's road cross section was composed of a compacted subgrade of crushed granite or greenstone designed to support the load, covered by a surface of light stone to absorb wear and tear and shed water to the drainage ditches. In modern macadam construction crushed stone or gravel is placed on the compacted base course and bound together with asphalt cement or hot tar. A third layer to fill the interstices is then added and rolled. Cement-sand slurry is sometimes used as the binder.

Macadam's renown is due to his effective and economical construction, which was a great improvement over the methods used by his generation. He emphasized that roads could be constructed for any kind of traffic, and he helped to alleviate the resentment travelers felt toward increasing traffic on the roads. His legacy lies in his advocacy of effective road maintenance and management. He advocated a central road authority and the trained professional official, who could be paid a salary that would keep him from corruption. This professional could give his entire time to his duties and be held responsible for his actions

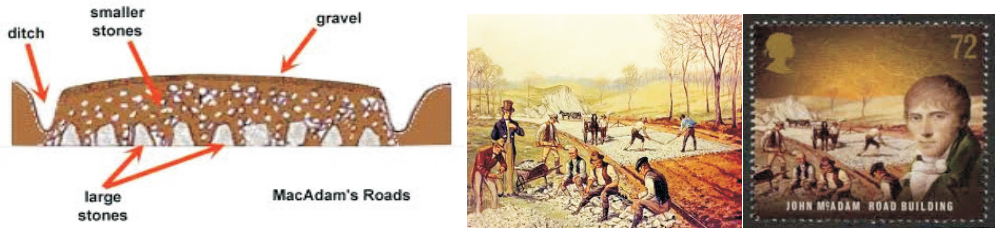


Figure 4 Macadam pavement construction

Thomas Telford, born in Dumfriesshire Scotland was a surveyor and engineer who applied Tresaguet's road building theories. In 1801 Telford worked for the British Commission of Highlands Roads and Bridges. He became director of the Holyhead Road Commission between 1815 and 1830. Telford extended Tresaguet's theories, but emphasized high-quality stone. He recognized that some of the road problems of the French could be avoided by using cubical stone blocks.
Telford used 30×25×15cm (12"x10") partially shaped pitchers, with a slight flat face on the bottom surface. He turned the other faces more vertically than Tresaguet's method. The longest edge was arranged crossways to the traffic direction, and the joints were broken in the method of conventional brickwork, but with the smallest faces of the pitcher forming the upper and lower surfaces.

9. DEVELOPMENT OF RAILWAY: -

Modern transportation of passengers and goods could not be imagined without trains, transport devices that revolutionized our industry, human expansion, and the way we can move from one place to another. Such important presence in our history appeared little over 200 years ago, but even then it was apparent that this new transportation paradigm could become one of the mankind's greatest fights if the technical hurdles of early industrial revolution could be overcome.

It all began in over 2000 years ago in ancient civilizations of Egypt, Babylon and Greece. Transport of people and goods in those time was done with carts that were pulled by animals (horses or bulls), and their engineers quickly noticed that animals will spend much less energy if the cart was traveling on predetermined path, without possibility for steering or traveling over uneven terrain. To enable this new way of transport, they build roads with pre-built constraints for wheels. These were the world's first railway tracks, and archeological remains of them can still be found in Italy and Greece. The most famous example of these ancient stone etched "wagon ways" can be found in the Isthmus of Corinth, Greece.

These wagon ways went out of use after the fall of Roman Empire, and managed to return only after increased trading and early industrial efforts of European Renaissance. By 18th century, every mine in Great Britain had its own simple railway network, with horses pulling carts from mines to factories. Changes to this kind of transport came in 1774 after the world found out about James Watt incredible discovery – stationary steam engine. As he protected his patents forcefully, the true widespread work on steam powered locomotives started only after his patent lapsed in 1800. Several inventors started working on improving Watt's design, most notably designing non-condensing high pressure chambers that enabled engine to convert more steam's power into mechanical energy.

First steam engines started running along primitive rail tracks in 1804. Matthew Murray managed to showcase his simple locomotive first, but Richard Trevithick received more attention with his "Penydarren" locomotive that pulled weight of 25 tons and 70 people during its first ride. This event proved to the engineer community, that pressurized steam engines indeed have enough power to become useful for transport of goods and people.

Commercial appearance of train networks came in late 1820s, and the pioneer in that field was English inventor George Stephenson who entered into competition that wanted to find out which steam locomotive design was easiest to use, most reliable and powerful. His "Rocket" won him that competition, showcasing to the entire world that steam trains are indeed destined for bright future. Designs of such

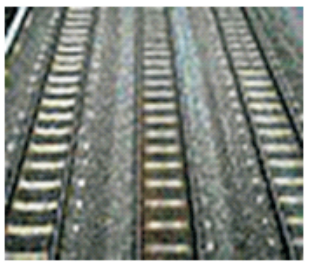
locomotives soon traveled to United States, where they began their rapid expansion across newly acquired lands and American long push to "civilize" the west frontiers.

As train technology received massive updates over those first few decades of public work, urban engineers in London started formulating first plans for inter-city railway tracks and underground tunnels. First section of now famous "London Underground" begun its work in 1863, and even though it received much complaints because of the smoke in the tunnels, it continued growing until 1890 when entire London train fleet started using electrical engines. This marked the beginning of the new era of urban rapid transit systems, and underground Metros started appearing across entire world (the word "metro" came from the name of Paris underground train system "Chemin de Fer Métropolitain", meaning "Metropolitan Railway").

Another very important moment in the history of the trains was introduction of Diesel engines, which brought the end to the age of steam locomotives. After second world war almost absolute majority of the world left steam behind, and embraced much faster, easier to maintain and reliable diesel fuel engines. As time went on, diesel engines became combined with electrical ones, enabling trains to use best of both worlds.

Today, trains represent one of the most important ways people and goods travel. Big cities cannot live without fully working underground metro systems that carry millions of people every day, and more heavy and durable industrial trains carry over 40% of worldwide goods between towns, countries, and continents.





10. Sailing the ship:-

1850 age of clipper ship
1869 Suez cannel open
1914 Panama cannel open

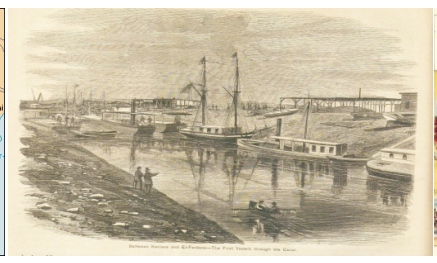



Figure 6 Suez cannel

11. THE AUTO DEBUTS: -

1880's Daimler & Benz build first successful autos with gasoline engines.

The first stationary gasoline engine developed by Carl Benz was a one-cylinder two-stroke unit which ran for the first time on New Year's Eve 1879. Benz had so much commercial success with this engine that he was able to devote more time to his dream of creating a lightweight car powered by a gasoline engine, in which the chassis and engine formed a single unit.

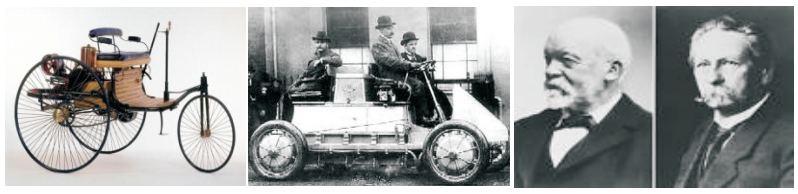


Figure 7 Daimler & Benz with auto

The major features of the two-seater vehicle, which was completed in 1885, were the compact high-speed single-cylinder four-stroke engine installed horizontally at the rear, the tubular steel frame, the differential and three wire-spooked wheels. The engine output was 0.75 hp (0.55 kW). Details included an automatic intake slide, a controlled exhaust valve, high-voltage electrical vibrator ignition with spark plug, and water/thermo siphon evaporation cooling.

On January 29, 1886, Benz applied for a patent for his "vehicle powered by a gas engine." The patent – number 37435 – may be regarded as the birth certificate of the automobile. In July 1886 the newspapers reported on the first Long-distance journey by Bertha Benz (1888)

Figure 8 Loong distance journey by B. Benze (1988)

Using an improved version and without her husband's knowledge, Benz's wife Bertha and their two sons Eugen (15) and Richard (14) embarked on the first long-distance journey in automotive history on an August day in 1888. The route included a few detours and took them from Mannheim to Pforzheim, her place of birth. With this journey of 180 kilometers including the return trip Bertha Benz demonstrated the practicality of the motor vehicle to the entire world. Without her daring – and that of her sons – and the decisive stimuli that resulted from it, the subsequent growth of Benz & Cie. in Mannheim to become the world's largest automobile plant of its day would have been unthinkable.

1916 (Federal Aid Road Act)[government would finance up to 50 percent of the cost of construction, not to exceed $10,000 per mile.]

12. Modern highway of INDIA:-

Figure 9 INDIAN NH, Motor vehicle act, Jayakar, IRC

1927-28 Jayakar Committee
1929 C.R.F

1939 Motor Vehicles Act
Nagpur Road Conference (1943-63)
N.T.P.C (1978)
Nagpur Road Conference (1943-63)
Bombay Road Plan (1961-81)
Lucknow Road Plan (1981-2001)
Highway Research Board (1973)

13. HISTORY OF RAIL TRANSPORT IN INDIA: -

The history of rail transport in India began in the mid-nineteenth century. The core of the pressure for building Railways, In India came from London. In 1848, there was not a single kilometre of railway line in India. A British engineer, Robert Maitland Brereton, was responsible for the expansion of the railways from 1857 onwards. The Allahabad-Jabalpur branch line of the East Indian Railway had been opened in June 1867. Brereton was responsible for linking this with the Great Indian Peninsula Railway, resulting in a combined network of 6,400 km (4,000 mi). Hence it became possible to travel directly from Bombay to Calcutta. This route was officially opened on 7 March 1870 and it was part of the inspiration for French writer Jules Verne's book Around the World in Eighty Days. At the opening ceremony, the Viceroy Lord Mayo concluded that “it was thought desirable that, if possible, at the earliest possible moment, the whole country should be covered with a network of lines in a uniform system”. 1907 almost all the rail companies were taken over by the government. The following year, the first electric locomotive made its appearance. With the arrival of World War I, the railways were used to meet the needs of the British outside India. With the end of the war, the railways were in a state of disrepair and collapse.

In 1920, with the network having expanded to 61,220 km (38,040 mi), a need for central management was mooted by Sir William Acworth. Based on the East India Railway Committee chaired by Acworth, the government took over the management of the Railways and detached the finances of the Railways from other governmental revenues.

The period between 1920 and 1929, was a period of economic boom; there were 41,000 mi (66,000 km) of railway lines serving the country; the railways represented a capital value of some 687 million sterling; and they carried over 620 million passengers and approximately 90 million tons of goods each year. Following the Great Depression, the railways suffered economically for the next eight years. The Second World War severely crippled the railways. Starting 1939, about 40% of the rolling stock including locomotives and coaches was taken to the Middle East, the railways workshops were converted to ammunitions workshops and many railway tracks were dismantled to help the Allies in the war. By 1946, all rail systems had been taken over by the government.

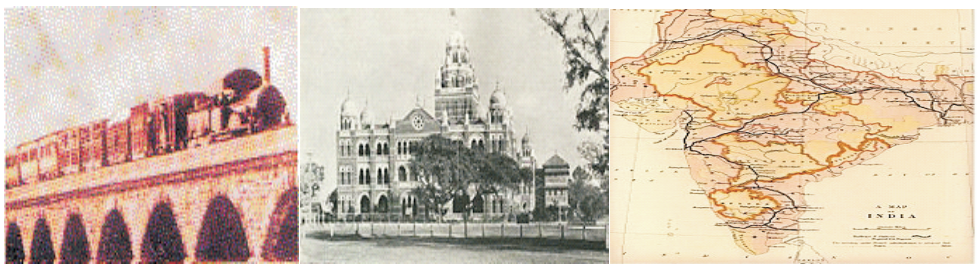


Figure 10 India's first train run between Bombay & Thane, The B.B & C.I railway head office 1905. Map of completed & planned rail line in 1871

14. TAKING FLIGHT:-

The Wright brothers, Orville (August 19, 1871 – January 30, 1948) and Wilbur (April 16, 1867 – May 30, 1912), were two American brothers, inventors, and aviation pioneers who were credited with inventing and building the world's first successful airplane and making the first controlled, powered and sustained heavier-than-air human flight, on December 17, 1903. From 1905 to 1907, the brothers developed their flying machine into the first practical fixed-wing aircraft. Although not the first to build and fly experimental aircraft, the Wright brothers were the first to invent aircraft controls that made fixed-wing powered flight possible.

The brothers' fundamental breakthrough was their invention of three-axis control, which enabled the pilot to steer the aircraft effectively and to maintain its equilibrium. This method became and remains

standard on fixed-wing aircraft of all kinds. From the beginning of their aeronautical work, the Wright brothers focused on developing a reliable method of pilot control as the key to solving "the flying problem". This approach differed significantly from other experimenters of the time who put more emphasis on developing powerful engines. Using a small homebuilt wind tunnel, the Wrights also collected more accurate data than any before, enabling them to design and build wings and propellers that were more efficient than any before. Their first U.S. patent, 821,393, did not claim invention of a flying machine, but rather, the invention of a system of aerodynamic control that manipulated a flying machine's surfaces

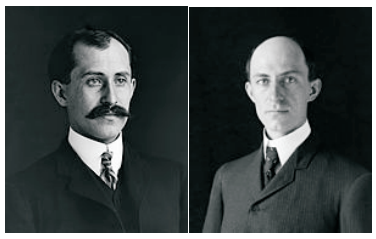


Figure 11 Wright Brother

1962 flight available for commercial services in India
1970 Jumbo jets also available

15. BEYOND THE EARTH:-

Spaceflight (also written space flight) is ballistic flight into or through outer space. Spaceflight can occur with spacecraft with or without humans on board. Examples of human spaceflight include the Russian Soyuz program, the U.S. Space shuttle program, as well as the ongoing International Space Station. Examples of unmanned spaceflight include space probes which leave Earth's orbit, as well as satellites in orbit around Earth, such as communication satellites. These operate either by telerobotic control or are fully autonomous.

Spaceflight is used in space exploration, and also in commercial activities like space tourism and satellite telecommunications. Additional non-commercial uses of spaceflight include space observatories, reconnaissance satellites and other earth observation satellites.

A spaceflight typically begins with a rocket launch, which provides the initial thrust to overcome the force of gravity and propels the spacecraft from the surface of the Earth. Once in space, the motion of a spacecraft — both when unpropelled and when under propulsion — is covered by the area of study called astrodynamics. Some spacecraft remain in space indefinitely, some disintegrate duringatmospheric reentry, and others reach a planetary or lunar surface for landing or impact

1969 - Man lands on Moon:- Apollo 11 was the spaceflight that landed the first humans on the Moon, Americans Neil Armstrong and Buzz Aldrin, on July 20, 1969, at 20:18 UTC. Armstrong became the first to step onto the lunar surface six hours later on July 21 at 02:56 UTC. Armstrong spent about two and a half hours outside the spacecraft, Aldrin slightly less, and together they collected 47.5 pounds (21.5 kg) of lunar material for return to Earth. A third member of the mission, Michael Collins, piloted the command spacecraftalone in lunar orbit until Armstrong and Aldrin returned to it just under a day later for the trip back to Earth.

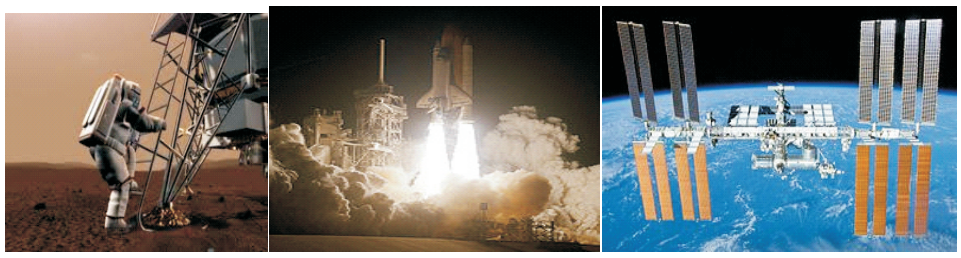


Figure 12 Transportation beyond the earth

1981 - Space Shuttle space Shuttle Columbia (NASA Orbiter Vehicle Designation: OV-102) was the first spaceworthy Space Shuttle in NASA's orbital fleet. First launched on the STS-1 mission, the first of the Space Shuttle program, it completed 27 missions before disintegrating during re-entry on February 1, 2003

near the end of its 28th mission, STS-107, resulting in the deaths of all crew members aboard

Now: International Space Station: - The International Space Station (ISS) is a space station, or a habitable artificial satellite, in low Earth orbit. It is a modular structure whose first component was launched in 1998. Now the largest artificial body in orbit, it can often be seen at the appropriate time with the naked eye from Earth. The ISS consists of pressurised modules, external trusses, solar arrays and other components. ISS components have been launched by American Space Shuttles as well as Russian Proton and Soyuzrockets. In 1984, the ESA was invited to participate in Space Station Freedom. After the USSR dissolved, the United States and Russia merged Mir-2 and Freedom together in 1993.

CONCLUSIONS

The early engineers, by their training, experience, and inclination, were often generalists. Many engineers worked pragmatically with a strong sense of physical and political reality. As the field became more diverse and complex, this was no longer possible. Growing federal, state, and local requirements called for a broad range of skills and capabilities, and new analysis tools. These new tools have in many ways transformed approaches to transportation engineering. But they have created many technical specialists who are often unfamiliar with or insensitive to many other aspects of transportation engineering. But, what is NEXT???.....

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