Highway Engineering

Third Class

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Transportation Engineering

Transportation engineering is a branch of civil engineering that involves the planning, design, operation, and maintenance of transportation systems to help build smart, safe, and livable communities.

Any system that moves people and goods from one place to other falls under the scope of transportation engineering, which includes:

- Highways and roadways
- Railways
- Oil pipelines
- Public transport systems
- Traffic control systems
- Automated transport systems
- Space transport systems

Highways 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.

Engineers in this specialization:

- Handle the planning, design, construction, and operation of highways, roads, and other vehicular facilities as well as their related bicycle and pedestrian realms
- Estimate the transportation needs of the public and then secure the funding for projects
- Analyze locations of high traffic volumes and high collisions for safety and capacity
- Use engineering principles to improve the transportation system
- Utilize the three design controls, which are the drivers, the vehicles, and the roadways themselves

The planning aspects of transportation engineering relate to elements of 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 (number of purposeful trips), trip distribution (destination choice, where the traveler is going), mode choice (mode that is being taken), and route assignment (the streets or routes that 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 transportation engineering because they often represent the peak of demand on any transportation system. Transportation

engineering, primarily involves planning, design, construction, maintenance, and operation of transportation facilities. The facilities support air, highway, railroad, pipeline, water, and even space transportation. The design aspects of transportation engineering include the sizing of transportation facilities (how many lanes or how much capacity the facility has), determining the materials and thickness used in pavement designing the geometry (vertical and horizontal alignment) of the roadway (or track). Before any planning occurs, an engineer must take what is known as an inventory of the area or, if it is appropriate, the previous system in place. This inventory or database must include information on population, land use, economic activity, transportation facilities and services, travel patterns and volumes, laws and ordinances, regional financial resources, and community values and expectations. These inventories help the engineer create business models to complete accurate forecasts of the future conditions of the system. Operations and management involve traffic engineering, so that vehicles move smoothly on the road or track. Older techniques include signs, signals, markings, and tolling. Newer technologies involve intelligent transportation systems, including advanced traveler information systems (such as variable message signs), advanced traffic control systems (such as ramp meters), and vehicle infrastructure integration. Human factors are an aspect of transportation engineering, particularly concerning driver-vehicle interface and user interface of road signs, signals, and markings.

Port and Harbor Engineering

Port and harbor engineers handle the design, construction, and operation of ports, harbors, canals, and other maritime facilities.

Airport Engineering

Airport engineers design and construct airports. Airport engineers must account for the impacts and demands of aircraft in their design of airport facilities. These engineers must use the analysis of predominant wind direction to determine runway orientation, determine the size of runway border and safety areas, different wing tip to wing tip clearances for all gates and must designate the clear zones in the entire port. The Civil Engineering Department, consisting of Civil and Structural Engineers, undertakes structural design of passenger, terminal design and cargo terminals, aircraft hangars (for parking commercial, private and government aircraft), runways and other pavements, technical buildings for installation of airport ground aids etc. for the airports in-house requirements and consultancy projects. They are even responsible for the master plan for airports they are authorized to work with.

Traffic Engineering

Is a branch of civil engineering that uses engineering techniques to achieve the safe and efficient movement of people and goods on roadways. It focuses mainly on research for safe and efficient traffic flow, such as road geometry, sidewalks and crosswalks, cycling infrastructure, traffic signs, road surface markings and traffic lights. Traffic engineering deals with the functional part of transportation system, except the infrastructures provided.

Importance of Transportation

Tapping natural resources and markets and maintaining a competitive edge over other regions and nations are linked closely to the quality of the transportation system. The speed, cost, and capacity of available transportation have a significant impact on the economic vitality of an area and the ability to make maximum use of its natural resources. Examination of most developed and industrialized societies indicates that they have been noted for high-quality transportation systems and services. Nations with well-developed maritime systems (such as the British Empire in the 1900s) once ruled vast colonies located around the globe. In more modern times, countries with advanced transportation systems such as in the United States, Canada, Asia, and Europe are leaders in industry and commerce. Without the ability to transport manufactured goods and raw materials and without technical know-how, a country is unable to maximize the comparative advantage it may have in the form of natural or human resources. Countries that lack an abundance of natural resources rely heavily on transportation in order to import raw materials and export manufactured products.

An Overview of Transportation History

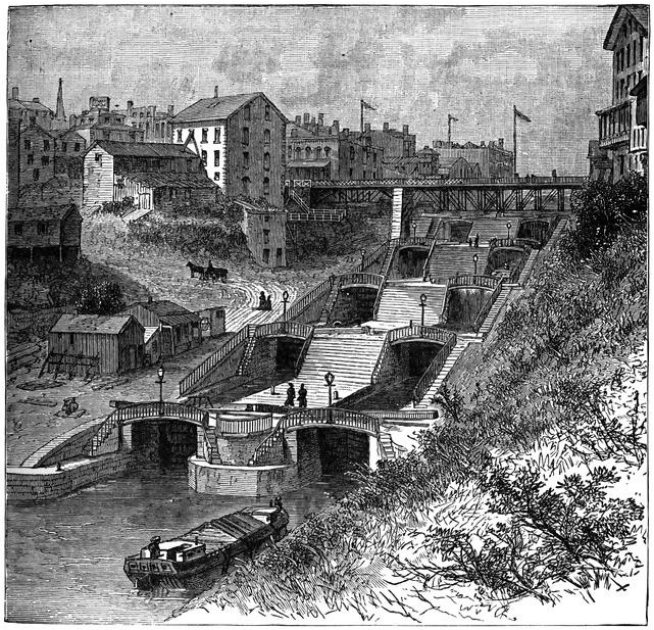
In its formative years, the United States was primarily rural, with a population of about four million in the late 1700s. Only about 200,000 persons or 5 percent of the population lived in cities; the remainder inhabited rural areas and small communities. That pattern remained until the early 1900s. During the twentieth century, the urban population continued to increase such that at present over 75 percent of the U.S. population lives in urban or suburban areas. Large cities have been declining in population, and increases have occurred in suburban and rural areas. These changes have a significant impact on the need for highway transportation.

Early Road Building and Planning

During the eighteenth century, travel was by horseback or in animal-drawn vehicles on dirt roads. As the nation expanded westward, roads were built to accommodate the settlers. In 1794, the Lancaster Turnpike, the first toll road, was built to connect the Pennsylvania cities of Lancaster and Philadelphia. The nineteenth century brought further expansion of U.S. territorial boundaries, and the population increased from three million to 76 million. Transportation continued to expand with the nation. The remainder of the nineteenth century saw considerable activity, particularly in canal and railroad building.

The Canal Boom

An era of canal construction began in the 1820s when the Erie Canal was completed in 1825 and other inland waterways were constructed. Beginning in the 1830s, this efficient means of transporting goods was replaced by the railroads, which were being developed at the same time. By 1840, the number of miles of canals and railroads was approximately equal (3200 mi), but railroads, which could be constructed almost anywhere in this vast, undeveloped land at a much lower cost, superseded canals as a form of intercity transportation. Thus, after a short-lived period of intense activity, the era of canal construction came to an end.



The Railroad Era

The railroad was the emerging mode of transportation during the second half of the nineteenth century, as railway lines were spanning the entire continent. Railroad dominated intercity passenger and freight transportation from the late 1800s to the early 1920s. Railroad passenger transportation enjoyed a resurgence during World War II but has steadily declined since then, owing to the competitiveness of the automobile. Freight rail was consolidated and remains viable. Railroad mileage reached its peak of about 265,000 miles by 1915.

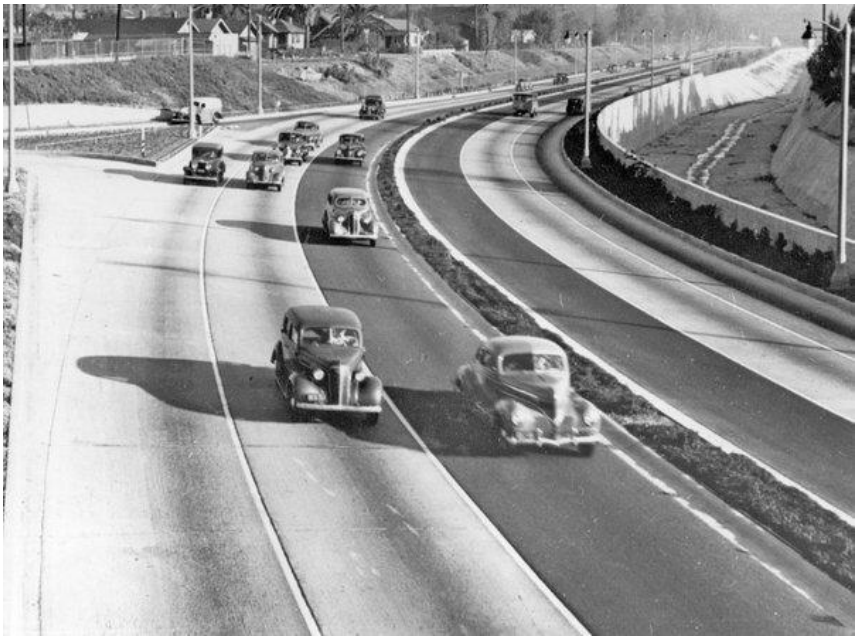
Transportation in Cities

Each decade has seen continuous population growth within cities, and with it, the demand for improvements in urban transportation systems has increased. City transportation began with horse-drawn carriages on city streets; these later traveled on steel tracks. They were succeeded by cable cars, electric streetcars, underground electrified railroads, and bus transportation. City travel by public transit has been replaced largely by the use of automobiles on urban highways, although rail rapid transit and light rail systems have been built in many large and medium-sized cities since the 1970s.

The Automobile and Interstate Highways

The invention and development of the automobile created a revolution in transportation in the United States during the twentieth century. No facet of American life has been untouched by this invention; the automobile (together with the airplane) has changed the way we travel within and between cities. Only four

automobiles were produced in 1895. By 1901, there were 8000 registered vehicles and by 1910, over 450,000 cars and trucks. Between 1900 and 1910, 50,000 miles of surfaced roads were constructed, but major highway-building programs did not begin in earnest until the late 1920s. By 1920, more people traveled by private automobile than by rail transportation. By 1930, 23 million passenger cars and three million trucks were registered. In 1956, Congress authorized a 42,500-mile interstate highway network, which is now completed.



The Birth of Aviation

Aviation was in its infancy at the beginning of the twentieth century with the Wright brothers' first flight taking place in 1903. Both World Wars I and II were catalysts in the development of air transportation. The carrying of mail by air provided a reason for government support of this new industry. Commercial airline passenger service began to grow, and by the mid-1930s, coast-to-coast service was available. After World War II, the expansion of air transportation was phenomenal. The technological breakthroughs that developed during the war (coupled with the training of pilots) created a new industry that replaced both ocean-going steamships and passenger railroads. A summary of the historical highlights of transportation development is shown in Table 1.1.

Important terms in transportation…

Speed: Speed is measured as the ratio of distance to the time in which the distance was covered. Speed is a scalar quantity as it has only direction and no magnitude.

Travel Speed: Speed of travel is the relationship between the traveled distance and the time it takes for a vehicle to travel it include all stops.

Design Speed: Design speed is a selected speed used to determine the various geometric features of the roadway. The assumed design speed should be a logical one with respect to the topography, anticipated operating speed, the adjacent land use, and the functional classification of the highway.

Operating Speed: operating speed - the speeds at which vehicles are observed operating during free flow conditions. Free flow speeds are those observed from vehicles whose operations are unimpeded by traffic control devices (e.g., traffic signals) or by other vehicles in the traffic stream

Flow: Vehicle traffic describes the number of vehicles that use a roadway during a specific period of time (e.g., number of cars per day on a specific roadway)

Density: Traffic density is the amount of traffic per unit of road length (e.g., cars per day per kilometer) and can be useful for comparing of the level of traffic between two or more areas.

Travel time: is the time taken by a vehicle to traverse a given section of a highway.

Running time: is the time a vehicle is actually in motion while traversing a given section of a highway.

Delay: is the time lost by a vehicle due to causes beyond the control of the driver.

Operational delay: is that part of the delay caused by the impedance of other traffic.