Transport, Traffic and Urban Engineering

30.1 INTRODUCTION

Transport engineering or transportation engineering is the science of safe and efficient movement of people and goods. It is a sub-discipline of civil engineering. Transportation contributes to the economic, industrial, social and cultural development of any country. Transportation is vital for the economic development of any region since every commodity produced, whether it is food, clothing, agricultural products, industrial products or medicine, needs transportation at all stages from production to distribution. In the production stage, transportation is required for carrying raw materials like seeds, manure, coal, steel, oil, etc. In the distribution stage, transportation is required from the production centres, namely, farms and factories to the marketing centres and later to the retailers and consumers for distribution.

30.2 THE PLANNING AND DESIGN ASPECTS OF TRANSPORT ENGINEERING

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), mode choice (such as what mode is being taken) and route assignment (such as which streets or routes are being used). More sophisticated forecasting can include other aspects of traveller decisions, including auto ownership, trip chaining and the choice of residential or business location. Passenger trips are the focus of transport engineering because they often represent the peak of demand on any transportation system.

The design aspects of transport 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 and designing the geometry such as vertical and horizontal alignment of the roadway or track.

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 traveller information systems (such as variable message signs), advanced traffic control systems and vehicle infrastructure integration. Human factors are an aspect of transport engineering, particularly concerning driver–vehicle interface and user interface of road signs, signals and markings. Transportation engineering is related to design and analysis of highways, railways, airports, urban and suburban road networks, parking lots and traffic control signal systems.

30.3 DIFFERENT MODES OF TRANSPORT

The basic modes of transport are by land, water and air. Land has given scope for development of road and rail transport. Water and air have developed waterways and airways, respectively. The roads or highways not only include the modern highway system but also the city streets feeder roads and village roads, catering to a wide range of road vehicles and pedestrians. Railways have been developed both for long distance transportation and for urban travel. Waterways include oceans, rivers, canals and lakes for the movement of ships and boats.

Aircrafts and helicopters use the airways. Apart from these major modes of transportation, other modes include pipelines, elevators, belt conveyors, cable cars, aerial ropeways and monorails.

The four major modes of transportation are:

1. Roadways or highways
2. Railways
3. Waterways
4. Airways

Transport by air is the fastest among the four modes. Air travel also provides more comfort apart from saving in transportation time for the passengers and goods between the airports. Transportation by water is the slowest among the four modes, but it is the most economical mode of transport. Water transport needs minimum energy to haul unit load through unit distance. Transportation by water is possible between the ports on the sea routes or along the rivers or canals where inland transportation facilities are available.

Transportation through the railways could be advantageous between stations both for the passengers and goods, particularly for long distances. Railway tracks serve as arteries for transportation by land and the roads could serve as feeder systems for transportation to the interior parts and to the intermediate localities between the railway stations. The energy requirement to haul unit load through unit distance by the railway is only a fraction (one fourth to one sixth) of that required by road. Transportation by road is the only mode that could give maximum service to one and all. This mode also has the maximum flexibility for travel with reference to route, direction, time, speed of travel, etc. through any mode of road vehicle.

30.4 HIGHWAY ENGINEERING

Highway engineering handles the planning, design, construction and operation of highways, roads and other vehicular facilities as well as their related bicycle and pedestrian realms. It estimates the transportation needs of the public and then secures the funding for the project and analyzes locations of high traffic volumes and high collisions for safety and capacity. Highway engineering uses civil engineering principles to improve the transportation system. A highway is defined as the main road intended for travel by the public between important cities and towns.

30.5 RAIL ENGINEERING

Railway engineers handle the design, construction and operation of railroads and mass transit systems that use a fixed guideway (such as light rail or even monorails). Typical tasks would include determining horizontal and vertical alignment design, station location and design and construction cost estimation. Railroad engineers can also move into the specialized field of train dispatching, which focusses on train movement control.

30.6 PORT AND HARBOUR ENGINEERING

Port and harbour engineers handle the design, construction and operation of ports, harbours, canals and other maritime facilities. This is not to be confused with marine engineering.

30.7 AIRPORT ENGINEERING

Airport engineers design and construct airports. Airport engineers must account for the impacts and demands of aircrafts in their design of airport facilities. One such example is the analysis of predominant wind direction to determine runway orientation.

30.8 TRAFFIC ENGINEERING

Traffic engineering is a branch of civil engineering that uses engineering techniques to achieve the safe and efficient movement of people and goods. It focusses mainly on research and construction of the immobile infrastructure necessary for this movement, such as roads, railway tracks, bridges, traffic signs and traffic lights.

Increasingly, however, instead of building additional infrastructure, dynamic elements are also introduced into road traffic management (they have long been used in rail transport). These use sensors to measure traffic flows and automatic, interconnected guidance systems (e.g. traffic signs that open a lane in different directions depending on the time of the day) to manage traffic, especially in peak hours.

The relationship between lane flow (Q) (vehicles per hour), maximum speed (V) (kilometres per hour) and density (K) (vehicles per kilometre) is $Q = KV$. Observation on limited access facilities suggests that up to a maximum flow, speed does not decline while density increases, but above a critical threshold, increased density reduces speed, and beyond a further threshold, increased density reduces flow as well. Therefore, managing traffic density by limiting the rate that vehicles enter the highway during peak periods can keep both speeds and lane flows at bottlenecks high. Ramp meters, signals on entrance ramps that control the rate at which vehicles are allowed to enter the mainline facility, provide this function (at the expense of increased delay for those waiting at the ramps).

Highway safety engineering is a branch of traffic engineering that deals with reducing the frequency and severity of crashes. It uses physics and vehicle dynamics, as well as road-user psychology and human factors engineering, to reduce the influence of factors that contribute to crashes.

Traffic engineering is closely associated with other disciplines such as:

1. Transport engineering
2. Highway engineering
3. Transportation planning
4. Urban planning
5. Human factors engineering

Highway engineering is the process of design and construction of efficient and safe highways and roads. It became prominent in the twentieth century and has its roots in the discipline of civil engineering. Standards of highway engineering are continuously being improved. Concepts such as grade, surface texture, sight distance and radii of horizontal bends and vertical slopes in relation to design speed and in addition to road junction design (intersections and interchanges) are all important elements of highway engineering. Most developed nations have extensive highway networks. Transportation planning is the field involved with the development of transportation facilities such as streets, highways, sidewalks, bike lanes and public transport lines. Transportation planning historically has followed the rational planning model of defining goals and objectives, identifying problems, generating alternatives, evaluating alternatives and developing the plan.

30.9 MUNICIPAL OR URBAN ENGINEERING

Municipal engineering is concerned with municipal infrastructure. This involves specifying, designing, constructing and maintaining streets, sidewalks, water supply networks, sewers, street lighting, municipal solid waste management and disposal, storage depots for various bulk materials used for maintenance and public works, such as salt and sand, public parks and bicycle paths. In the case of underground utility networks, it may also include the civil portion of the local distribution networks of electrical and telecommunication services. It can also include the optimizing of garbage collection and bus service networks. Some of these

disciplines overlap with other civil engineering specialities; however, municipal engineering focusses on the coordination of these infrastructure networks and services, in as much as they are often built simultaneously and managed by the same municipal authority.

Municipal or urban engineering combines elements of environmental engineering, water resources engineering and transport engineering. Municipal engineering may be confused with urban design or urban planning. Whereas the urban planner may design the general layout of streets and public places, the municipal engineer is concerned with the detailed design. For example, in the case of the design of a new street, the urban planner may specify the general layout of the street, including landscaping, surface finishing and urban accessories, but the municipal engineer will prepare the detailed plans and specifications for the roads, sidewalks, municipal services and street lighting.