

Route AssignmentTraffic Engineering
Transportation planning

Traffic assignment is the stage in the transport planning process wherein the trip interchanges are allocated to different parts of the network forming the transport system. In this stage

- (i) the route to be travelled is determined.
- (ii) The inter-zonal flows are assigned to the selected routes.

The application of traffic assignment are

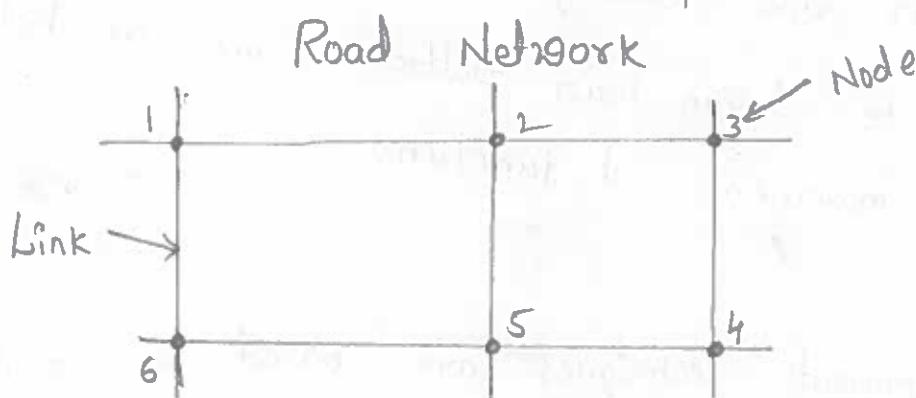
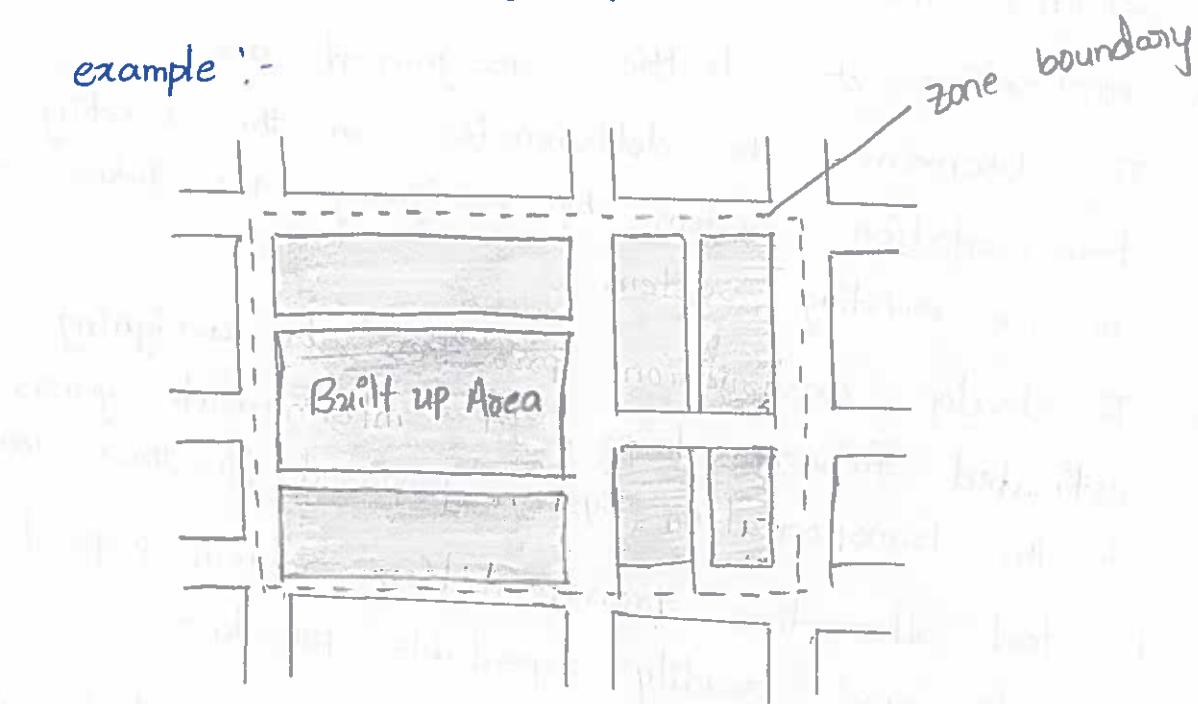
- (i) To determine the deficiencies in the existing transportation system by assigning the future trips to the existing system.
- (ii) To develop construction priorities by assigning estimated future trips for intermediate years to the transportation system proposed for those years.
- (iii) To test alternative transportation system proposals by systematic and readily repeatable procedures.
- (iv) To provide design hour traffic volumes on highway and turning movements at junctions.

General Principles:

All the assignment techniques are based on route selection the choice of the route is made on the basis of a ~~number~~ on journey time, length, cost comfort, convenience and safety.

The highway network is described by a system of links and nodes. A link is a section of a highway network between two intersections. A node is the centroid of a zone or the intersection of two or more links. Usually local and minor streets are not included in the coded highway network.

example :-



each node is specified by a numerical code and each link is described by its end node.

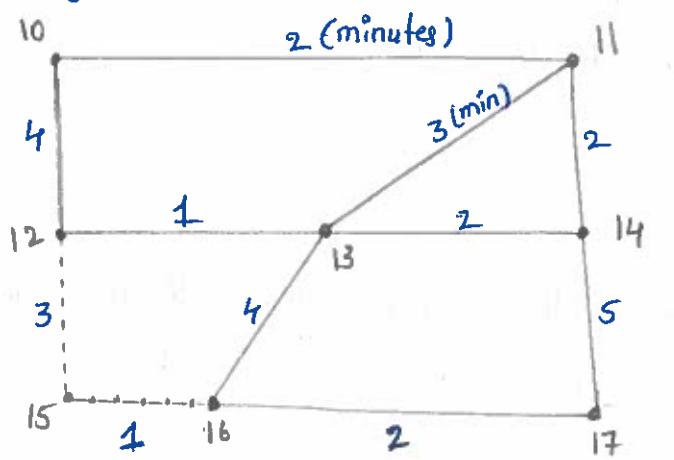
The Minimum Path

The minimum path may be that route to travel, which has least accumulation of time, distance or other parameters.

The sequence of nodes, which defines the links comprising the minimum path from a zone-centroid to the other points of interest in a network is called the "tree".

The tree is determined by starting from the zone centroid and progressively selecting the shortest path to the other nodal points in the network.

1. Example :- The network shown consists of zone centroid 15 and a number of nodes and links. Build the minimum path tree from zone centroid 15 with given travel time in minutes.



Solⁿ :→ starting from centroid 15, we go to each connecting node and note the time of travel to each node
Thus

$$T_{15-16} = 1$$

$$T_{15-12} = 3$$

- The node closer to the centroid 15 in time is considered next. thus, node 16 is taken up next.
- From node 16, the cumulative time to travel from the centroid to another node, directly connected to node 16 is then found. thus,

$$T_{15-16-13} = 5$$

$$T_{15-16-17} = 3$$

- The next closest node to centroid 15 is now taken up. Accordingly, we find that nodes 12 and 17 have the same travel time of 3 minutes.

~~$T_{15-16-13-12}$~~ ~~$T_{15-16-13-17}$~~

~~$T_{15-16-17}$~~

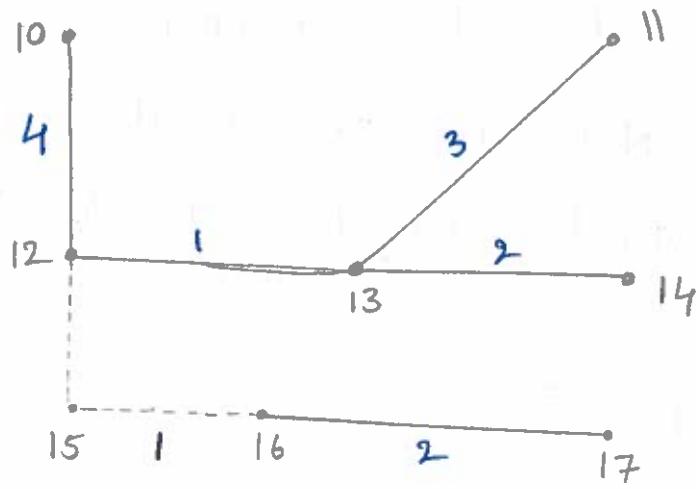
In such a case, the node with smaller number can be taken up first. Thus

$$T_{15-12-13} = 4$$

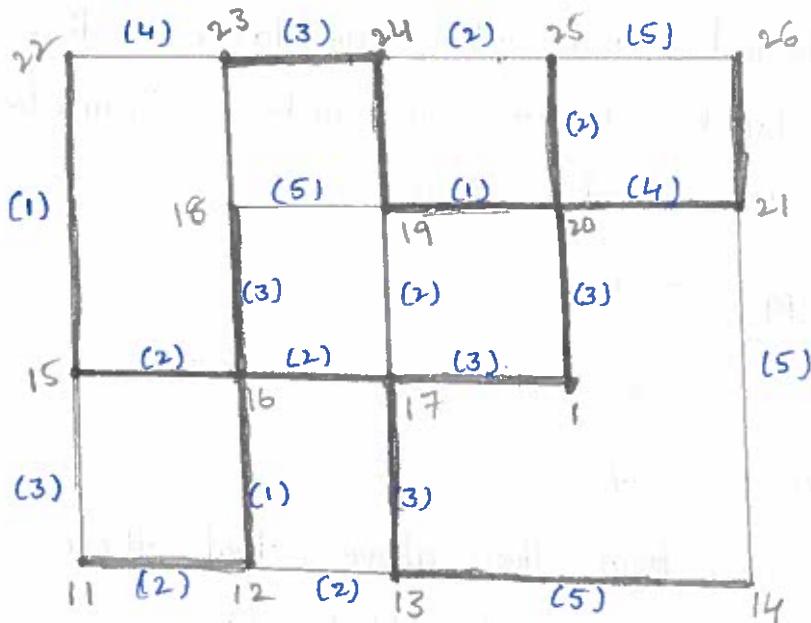
$$T_{15-12-10} = 7$$

It can be seen from the above that there are two possible routes to reach node 13, i.e., 15-16-13 and 15-12-13.

This process is repeated till all the nodes have been covered by shortest path. The minimum path tree, the minimum path tree, thus developed, is shown in the fig.



Example :- 2



- The above diagram consists of a zone centroid 1 and a number of links and nodes.
 - starting from centroid 1. we go to each connecting node and note the time of travel to the node.
- $T_{1-20} = 3$
- $T_{1-17} = 3$
- Next The node close to centroid 1 & is considered but time taken to reach both the nodes being the same.

The node having the lower number i.e 17 is taken up. From Node 17, the cumulative time to travel from Centroid connected directly to Node 17 is noted.

$$T_{1-17-19} = 5$$

$$T_{1-17-16} = 5$$

$$T_{1-17-13} = 6$$

The next closest node to centroid 1, i.e Node 20, is now considered and the cumulative time to travel from centroid 1 to all nodes connected directly to it are noted. Thus:

$$T_{1-20-19} = 4$$

$$T_{1-20-25} = 6$$

$$T_{1-20-21} = 7.$$

It will be seen from the above that there are two possible routes to reach Node 19, i.e 1-17-19 and 1-20-19. from which shorter in time is chosen. This process is repeated until all nodes have been covered by the shortest path. The minimum path tree is indicated with thick line in fig.

(4)

Traffic Assignment Techniques :-

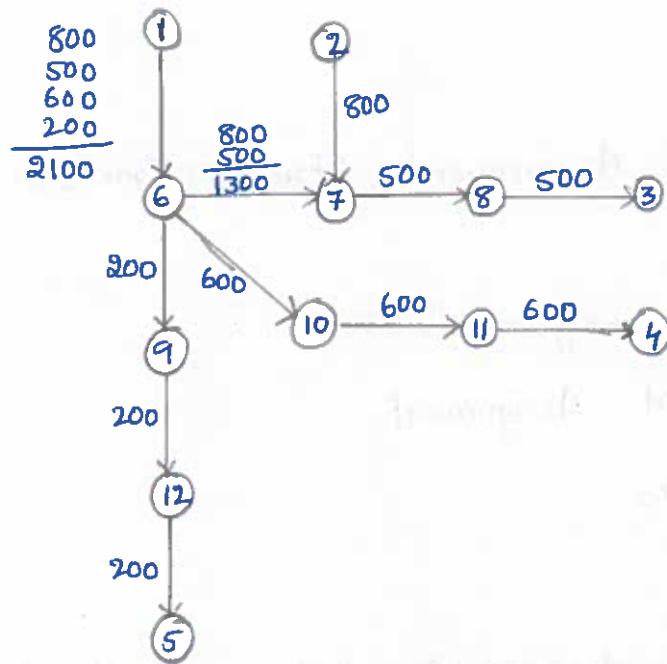
1. All-or-Nothing Assignment (Free assignment or Desire assignment)
 2. Multiple route assignment
 3. Capacity restraint Assignment
 4. Diversion curves
1. All-or-Nothing assignment :-

The All-or-Nothing Assignment technique allocates the entire volume of traffic interchanging between pairs of zones to the minimum path calculated on the basis of free flow link to the minimum path tree.

After all interchange volumes are assigned, the flow on a particular link is computed by summing of all the interzonal flows that happen to include that link on their minimum paths.

example : Assign the following interzonal vehicular trips emanating from zone 1 to the network of ~~the previous example~~ Zone Centroid 2, 3, 4, 5, are given below

J	2	3	4	5
01J	800	500	600	200



Traffic flow (Vehicles/hour)

Link Traffic flow (Vehicles/hour)

1 - 6 2100

6 - 7 1300

6 - 9 200

6 - 10 600

7 - 2 800

7 - 8 500

8 - 3 500

10 - 11 600

11 - 4 600

9 - 12 200

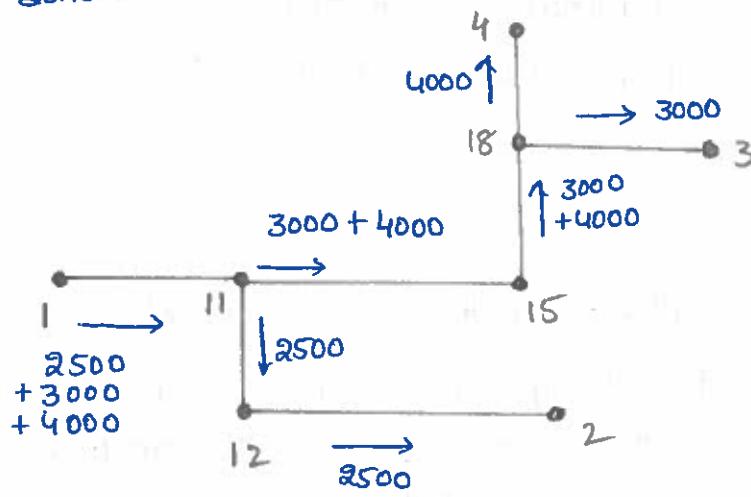
12 - 5 200

Example 2 :-

Shows the minimum path tree connecting Zone Centroid 1 with zone centroid 2, 3 and 4. The traffic volume from zone centroid 1 to zone centroids 2, 3, and 4 are given here :

From Zone Centroid	To Zone Centroid	Traffic Volume (Vehicles / hour)
1	2	2500
1	3	3000
1	4	4000

It is required to assign the flow from zone centroid 1 to zone centroids 2, 3 and 4.



Link	Traffic flow (Vehicles / hour)
1 - 11	9500
11 - 12	2500
12 - 2	2500
11 - 15	7000
15 - 18	3000
18 - 3	3000
18 - 4	4000

Step 1 : Find shortest route b/w Traffic Area Assignment zones

Step 2 : Assign all trips to links containing shortest route

Step 3 : Continue until trips b/w all traffic assignment Pairs have been assigned.

This is simple, inexpensive and fast method

The disadvantage of this method is too many vehicles assigned to more attractive routes. This may cause increase congestion on these routes so travel time is increase. It generates unrealistic flow patterns in situations where there are minor differences in travel impedance between alternative routes.

2. Multipath Assignment

In essence, the all-or-nothing assignment assumes that all trip-makers travelling between a specific pair of zones actually select the same path. In reality, however, interchange volumes are divided among a number of paths.

Algorithms that are capable of determining several paths between each pair of zones in order to increasing impedance are available.

Therefore it is possible to ~~not~~ assign the traffic volume between these paths according to some realistic rule.

For example, Irwin and Von Cube suggested the following inverse-proportion function to compute the fraction to be assigned to each of a number of interzonal routes.

$$P(r) = \frac{W_{ir}^{-1}}{\sum_n W_{in}^{-1}} \quad \text{--- (1)}$$

where W_{ir} is the impedance of route r from i to j
 $P(r)$ is proportion of ~~route~~ ~~the~~ traffic
 assigned to route r

$\sum_n W_{in}$ sum of impedance of all the routes

example :-

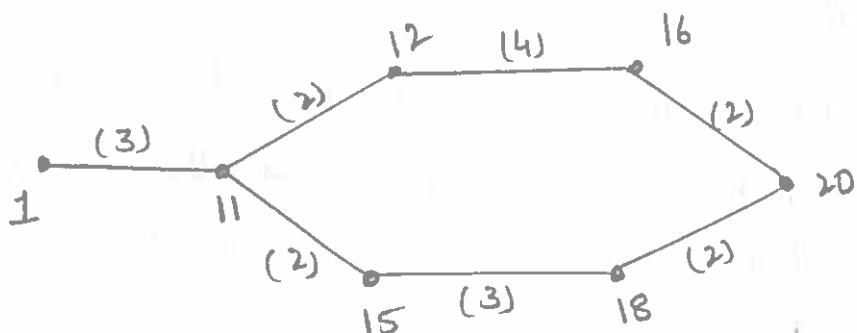
The details of travel time and capacity of different links of road network is as follows.

link	Travel time in minutes	Practical capacity in PCU / hr
1-11	3	9000
11-15	2	7000
11-12	2	8000
12-16	4	9000
15-18	3	8000
16-20	2	7000
18-20	2	6000

Assign a traffic volume of 9000 PCU / hour between nodes 1 and 20 by multiple route assignment technique.

Soln

The given Road network is as follows



The two alternative routes from 1 to 20 are:

(i) 1-11-15-18-20 = 10 min, and

(ii) 1-11-12-16-20 = 11 min

As per eq ① the proportion using route (i) is

$$\frac{\frac{1}{10}}{\frac{1}{10} + \frac{1}{11}} = 0.524$$

Hence, the traffic assigned to route (i)

$$= 0.524 \times 9000 = 4716 \text{ PCU/h}$$

As per eq ① the proportion using route (ii) is

$$\frac{\frac{1}{11}}{\frac{1}{10} + \frac{1}{11}} = 0.476$$

Hence, the traffic assigned to route (ii)

$$0.476 \times 9000 = 4284 \text{ PCU/h}$$

3 Capacity Restraint Assignment

As the road traffic flow increased toward capacity, the average speed of vehicle decreases from the free flow speed to the speed at maximum flow.

It is to be noted that the interzonal flows assigned to the minimum paths on the basis of free-flow link impedances (usually travel times).

But ~~if the link flows were at the levels~~
But if the traffic flows ~~were~~ by the assigned route, the vehicle speed would be lower and travel time would be higher than free-flow

As a result, the minimum paths computed to trip assignment may not be the minimum paths after the trips are assigned.

Some of the methods of capacity restraint are given below

- (i) Smock method :- In this method, the all-or-nothing assignment is first worked out. In this method the link travel times are modified according to the function

$$T_A = T_0 e^{(\frac{V}{C} - 1)}$$

$$T_A \leq 5T_0$$

T_0 = original travel time (at zero travel time of vehicle when volume equals capacity).

T_A = Adjusted travel time

e = exponential base

V = assigned volume

C = assigned traffic capacity

- 2) The Bureau of public Roads :- *Access*

$$T_N = T_0 \left[1 + 0.15 \left(\frac{V}{C} \right)^4 \right]$$

T_N = link travel time at assigned volume

T_0 = base travel time at zero volume

V = Volume

C = Capacity

4. Diversion Curves

Problem: In order to relieve congestion on an urban street network a motorway is proposed to be constructed. The travel time from one zone centroid to another via the proposed motorway is estimated to be 10 minutes whereas the time for the same travel via the existing streets is 18 minutes. The flow between the two zone centroids is 1000 vehicles per hour. Assign the flow b/w the new motor way and existing streets.

Solⁿ

Using eq'n

$$P = \frac{100}{1+t_R^6}$$

$$t_R = \frac{10}{18} = 0.56$$

$$P = \frac{100}{1+(0.56)^6} = 96.57$$

traffic diverted to the new motorway

$$= 1000 \times 96.57$$

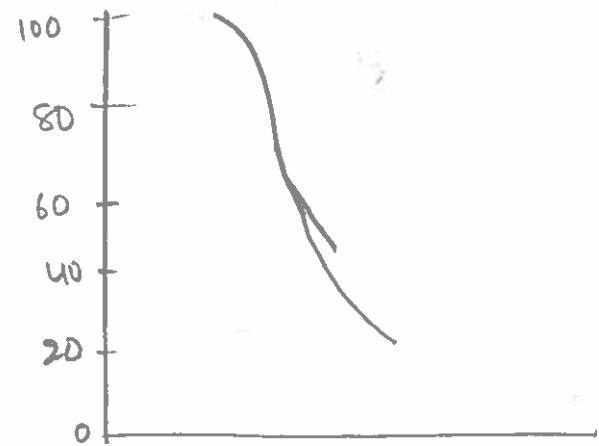
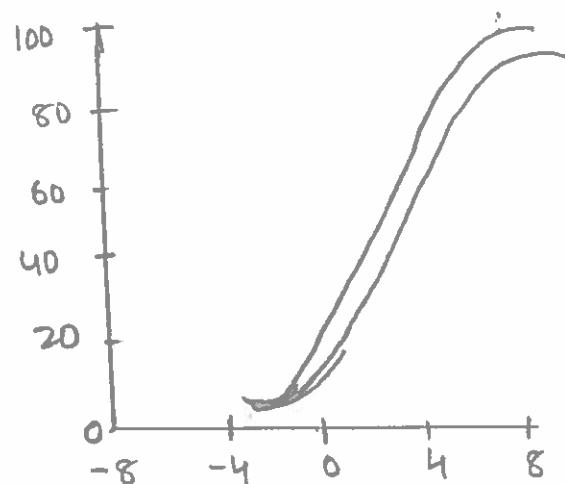
$$= 965 \text{ veh / hour}$$

and traffic using the existing streets

$$= 35 \text{ veh / hour}$$

One of the frequently used assignment techniques is the diversion curves. These curve represent the proportion of traffic that is likely to be diverted to on a new facility (by pass, new expressway). Once such facility is constructed. Diversion curves can be constructed using variables such as

- (i) Travel time saved (ii) Distance saved
- (iii) Travel time ratio (iv) Distance ratio
- v) Travel time & Distance Saved.
- vi) Distance & speed ratio
- vii) Travel cost Ratio



imported from Europe to America will be 300,000
ducks per year, and the market can be easily supplied by
the 40,000,000 hens which are now in the country, and
with the same 40,000,000 hens we can supply 100,000
ducks daily, and the market will be saturated with
them. At present the market is about 100,000 ducks per day,
but it is only a question of time when the market will be
fully supplied.

The market for ducks is now very limited, and

will probably remain so for a long time.

The market for geese is also very limited,

and there is no market for them at all.

The market for turkeys is also very limited, and

there is no market for them at all.

The market for pheasants is also very limited, and

there is no market for them at all.

The market for quails is also very limited, and

there is no market for them at all.

The market for partridges is also very limited, and

there is no market for them at all.

The market for pigeons is also very limited, and

there is no market for them at all.

At the present time