CE-351 26=০৬ HASIB SIR

Transportation planning: 06/08/04

Transportation planning consists of two terms:-

(I) Transportation.

(II) Planning.

Transportation means the movement of goods and people. planning means to find out a goal. If the goals are different then the activities will be different. Planning must have alternatives. The goals of the roadway transportation is to produce a safe efficient and convenient system.

SEC

Transportation planning is primarily the process of producing information that can be used by the decession makers to better understand the consequences of different course of actions.

⇒ planning is undertaken for four reasons:-

(I) To ensure the efficient allocation of resources.

(II) To ensure the equitable allocation of resources.

(III) To widen the community choices by offering alternatives and options.

(IV) To make possible prediction of future needs and the consequences of proposed scheme.

Equity may be two types:- (I) on the basis of needs.

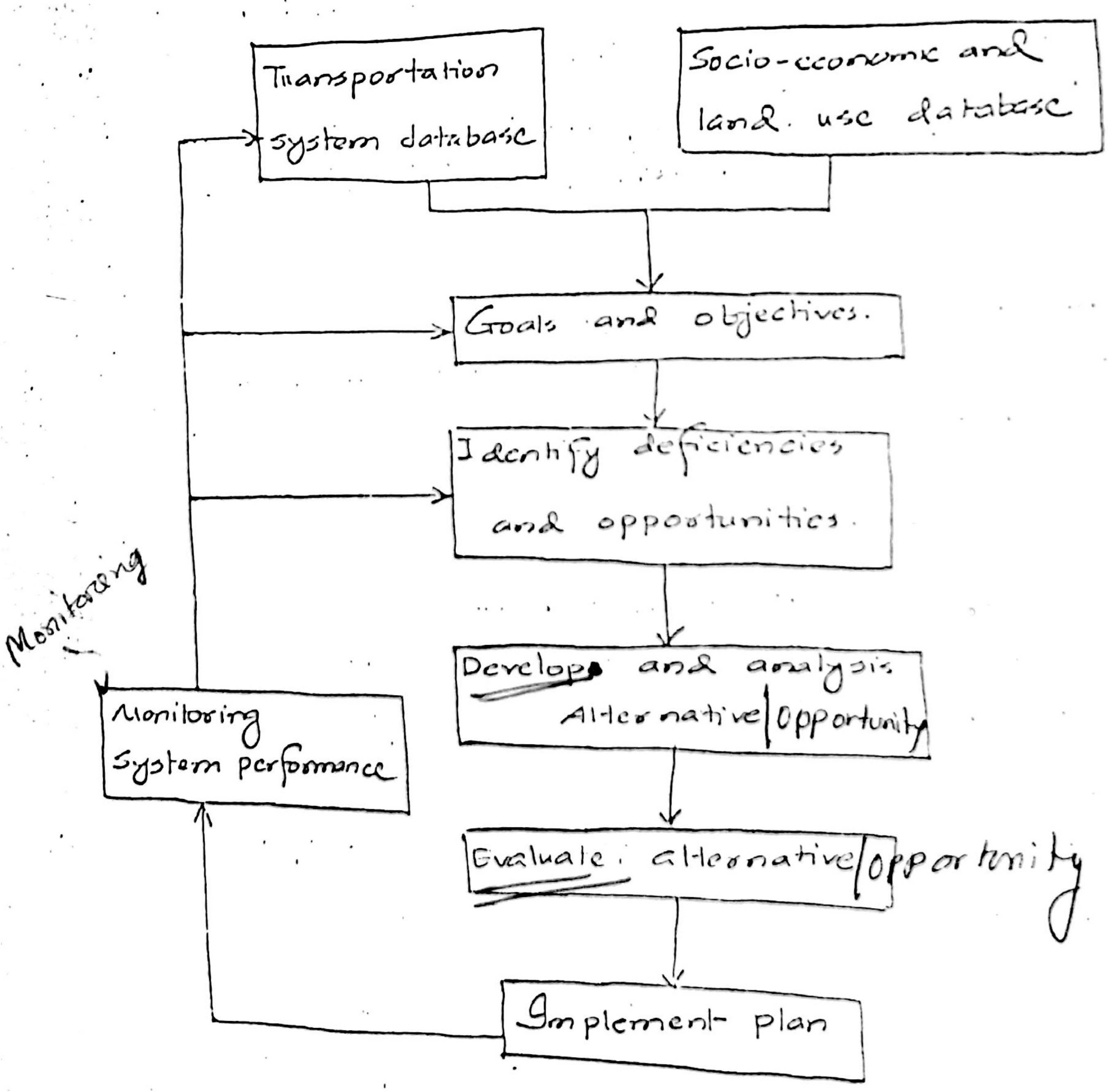
(II) on the basis of contribution.

591

108

Basic Elements of Transportation planning:

Transportation planning is primarily a process of prod[...] information that can be used by the decision-makers to he[...] understand the consequence of different course of action.



Transportation System Modeling:

Transportation planning is concerned with the future demand and putting in place the facilities and services that will accomodate these demands. The main challenge of the transportation planner is to make a reliable forecast that will effect the population social and economice condition as well as the change in traffic netwoork. Factors affecting the growth of personal travel are given below:-

- Trips per capita.
- person / household
- Population
- Employment

Population → Person trip length
Employment → Person trip length

*Recognized components of traffic travel demand include:- '07, '09

'10-11, '08-09,

01) Existing traffic:

Traffic currently used in an existing highway that is to be improved.

02) Normal traffic Growth:

Traffic can be explained by:-

(i) anticipated growth in state and regional population

(ii) Areawise change in land use.

03) Diverted traffic

Traffic that is switched to a new facility from nearby roadways.

04) Converted traffic:

Traffic changes resulting from change of mode.

05) change of destination traffic

Traffic has been changed to different destinations, where such change is attributed to attractiveness of the improved transport and not to change in land use.

attractive to transports

06) Development traffic

Traffic due to the improvement in adjacent land in addition to the development that have been taken place had the new or improved highway not been constructed

07) Induced traffic

Traffic that represent the trips that would not have made but now are because of improved transportation

END CE DT

Basic Concept In Transportation System Modeling:

Most of the transportation models are based on some fundemental assumptions and approaches that will heavily influence how these models are used by transportation planners and engineers. The most important are as follows:

Tripmaking is a function of land use

- The concept of derived demand is a critical point of departure in model development.
- Most of the models are developed on the assumption that tripmaking is related to types of land use at the origin and destination ends of the trip.

Trips are made for different Purpose:

Modeling is based on the type of activities and land use at the both ends of the trip. The modeling process often treats these trips separately and aggregates them at the end for estimation of total no. of trips in the network. Trips are made for accomplishing different activities.

Trips are made at different time at the day.

The basis of most of the modeling is to determine the origin and destination patterns in a study area. These patterns largely depend on time as different types of trip is made at different times of the day. Thus modeling is often done with origin-destination trip table to represent different trip period.

Travelers have different options available to them:

It is important not only to know the origin-destination pattern but the travelers have the option of trip making using different modes as well as different paths in the network

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Trips are made to minimize the level of ...
with the reaching a destination:

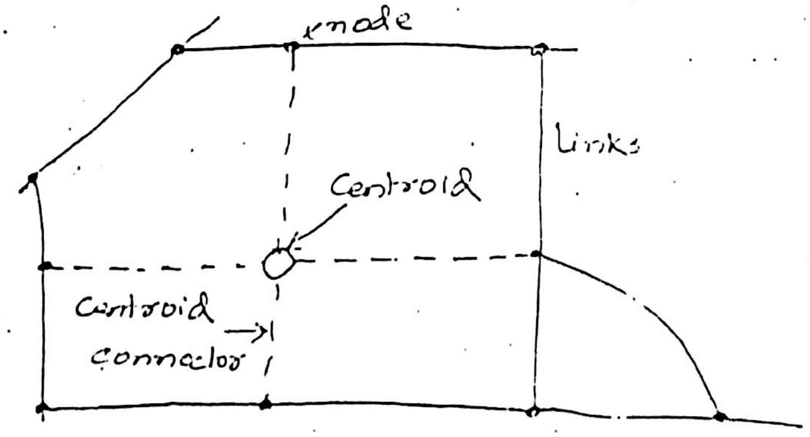
* The choice of modes depend on:-
  * (i) trip time / travel time associated with reaching the destination
  * (ii) expense of the mode to reach destination

The choice of paths through a network is often based on the assumption that the minimum amount of time it takes to go to the destination.

Transport networks and traffic analysis zones are the ... of system modeling

Given numerous origins and destination in a study area and a given the different paths that can be used to reach destinations, transport models must be able to represent the land use pattern and network characteristics that are the fundemental of trip estimation.

The transport system often pictured as a network links and nodes. the conceptually represents the roads and Intersection. The figure given below represents the transport network



Steps of Transportation Modeling:

Four steps :- (i) Trip generation :- no of trips produced in traffic analysis zone (T_i)

(ii) Trip Distribution :- no of trips generated @ zone i and attracted to zone j (T_{ij})

(iii) Mode split: no of trip produced at zone i and attracted to zone j travelling by mode m (T_{ijm})

(iv) Trip assignment : no. of trip produced in zone i and attracted to zone j travelling by mode m and by route r (T_{ijmr})

* Trip generation:

Trip generation step in transportation modeling relates the number of trips that have been produced at zone by time period and to the land use and demographic characteristics of the location. A necessary step input into the trip generation is to have some identification of what the land use and demographic characteristics are likely to be. Special models are used to estimate population, number of dwelling units, auto ownership, income, employment and retailment zone. In many cases, specially in regional and stateside planning these future estimates are provided by economic and demographic planners rather than transport professionals.

Studies have shown that the rate of trip making is closely related to three characteristics of land use :-

(i) Intensity of land use.
(ii) character of land use
(iii) location relative to major economic activities.

There are various method to estimate the trip producing activities that are happened in a particular zone. Three of most common methods to estimate trip rate :-

(i) Trip rates from National / local sources.
(ii) Cross classification analysis.
(iii) Regression analysis.

Trip rates from national/local sources:

planners often undertake studies to determine the number of trips that are made associating with the land use. For example, traffic counts at the driveways of store and restaurant to count the number of vehicles that are attracted to these place. The Institute of Transportation Engineers (ITE) publishes the trip generation Hand book - that compiles the trip rates that have been occured throughout the USA. In absence of such local information, Hand book is often used as a source of information of trip rates.

Cross Classification analysis:

If good datas are available to provide information on the relation between socio economic variables and trip making cross classification analysis can be used to develope relevant trip rates. Datas about the population of a community, persons/Household, the corresponding no of trips can be known from census. By estimating the number of future households and applying the calculated trips, future number of trips can be estimated in a zone.

Regression Analysis:

Given high correlations that typically varies and exists between trip rate and socio economic variables, many model u. least-square regression to estimate trip production per zo The ITE Handbook also provide regression equation to estim no. of trip making based on certain types of land use.

→ Trip Distribution:

The major product of the trip distribution step is to provi a trip table, an origin-destination matrix that shows the no. o trips that are generated from a particular zone and where the are destined to. The major method of producing such trip ta is the gravity model.

This gravity model is named because of it similarity with Newton's law of gravity. Employed first for sociological and marketing research but in 1950s the model is used to transportation modelling. Since than the model has been sligh modified and has become the predominant technique for transportation modeling.

let total no of P_i trips are made frome zone i and T_{ij} of them are destined to zone j for a specified purpose. The distance between zone i and j is D_{ij}. If A_j is a measure of attraction of zone j for this purpose and n is the exponent of tha varies with trip purpose. The gravity model can be writtem as :-

$$T_{ij} = \frac{\frac{A_j}{(D_{ij})^n}}{\sum_{j=1}^{m} \frac{A_j}{(D_{ij})^m}} P_i$$

The gravity model has been modified In recent years that reflects the research and experience with the model. It has been found that travel propensity decreases not only with travel length but travel - time to distance. It has been established that the exponent of travel time, n not only varies with travel purpose but also with trip length. Trip distribution analyses are therefore usually stratified according to the travel time, with calibrated value of exponent being determined for a given city and given trip. To facilitate efficient computer use of gravity model, it is now well practice to represent the effect of spatial separation in form of travel time factors,

$$F = \frac{C}{t^n}$$

Here C is a constant. Instead of surrogate measures of attractiveness such as commercial floor space, actual zonal trip attractions are used in the eqn. Currently the recommened gravity model is :-

$$T_{ij} = \frac{A_j F_{tij} K_{ij}}{\sum_{\text{all zones}} A_j F_{tij} K_{ij}} P_i$$

Here, F_{1ij} = travel time factor for travel between zone i to.

K_{ij} = Socio economic adjustment factor between i and j

A_j – total attraction at zone j

*** Mode Spilt Model**

Mode split model is to predict the number of travelers who choose one mode over another for making particular trip. A gre deal of research have been undertaken to better specify models will correctly reflect the individual decision-making process making this choice. Emperical evidence indicates the following factors influence mode choice :-

(I) Type of trip.

(II) characteristics of trip maker.

(III) characteristics of transportation system.

The most recent advance in transportation modeling have on what are called individual choice models. which relate mo choice to the utility associated with each mode. The utility as attractiveness of the each mode can be defined as a variety variables relating to travel costs, travel time, reliability and Different mode formulation have been used to predict mod. based on different modal utilities, but the most common formulation is called the logit model and is of following

$$P_{ti} = \frac{e^{U_{it}}}{\Sigma e^{U_{it}}}$$

P_{ti} = Probability of individual t choose mode i

U_{it} = utility of mode i to individual t.

Measures of effectiveness used in evaluation:

01. Transportation system performance:

- Number of trips by mode
- Vehicle miles traveled.
- Congestion
- Peak hour congestion.
- Transit boardings.
- Highway level of service

02. Mobility:

- mobility option
- Improved movement of people

03 Accessibility:

- percent within 30 minutes etc.
- Transit and highway speed.

01.

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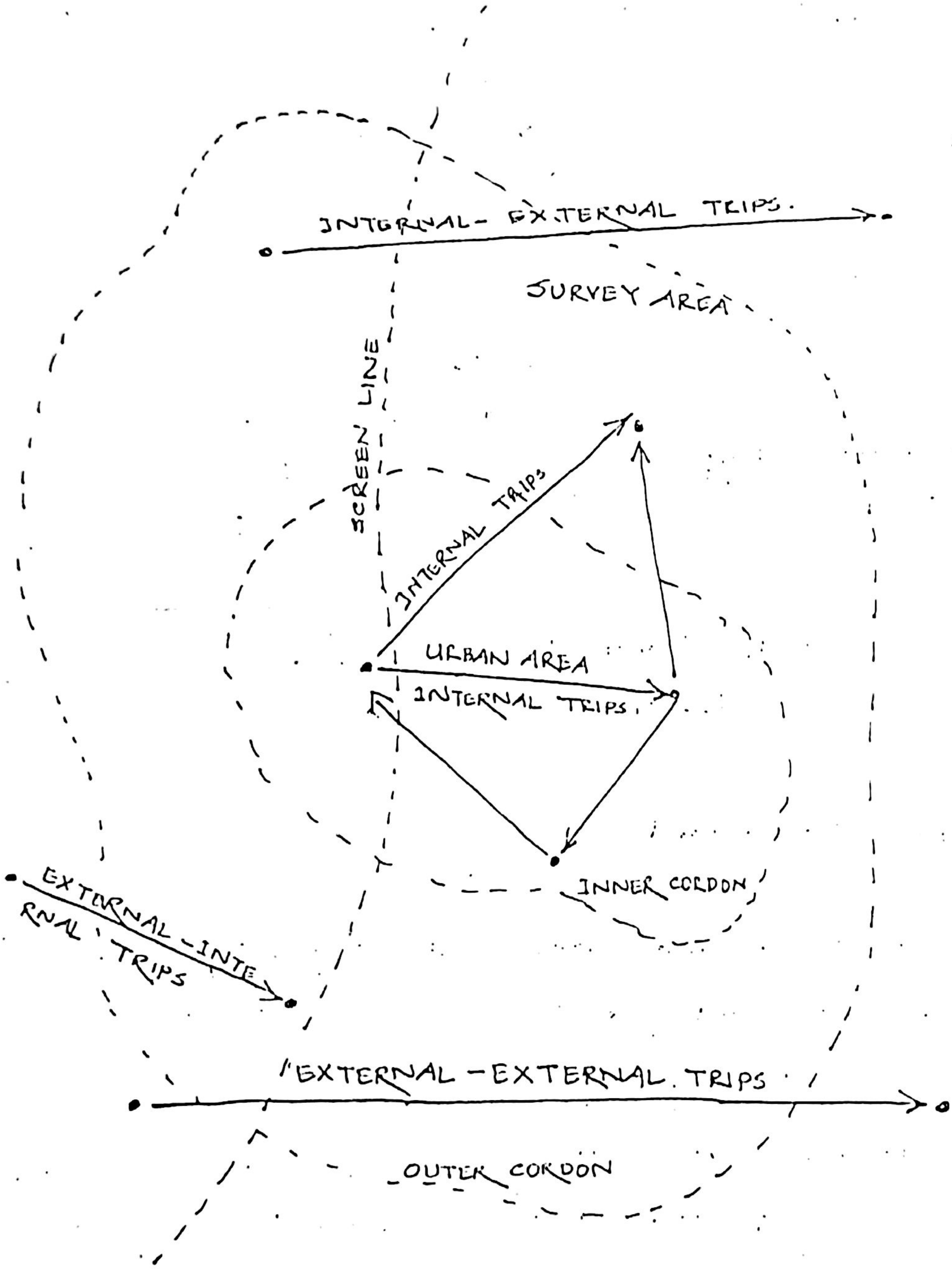
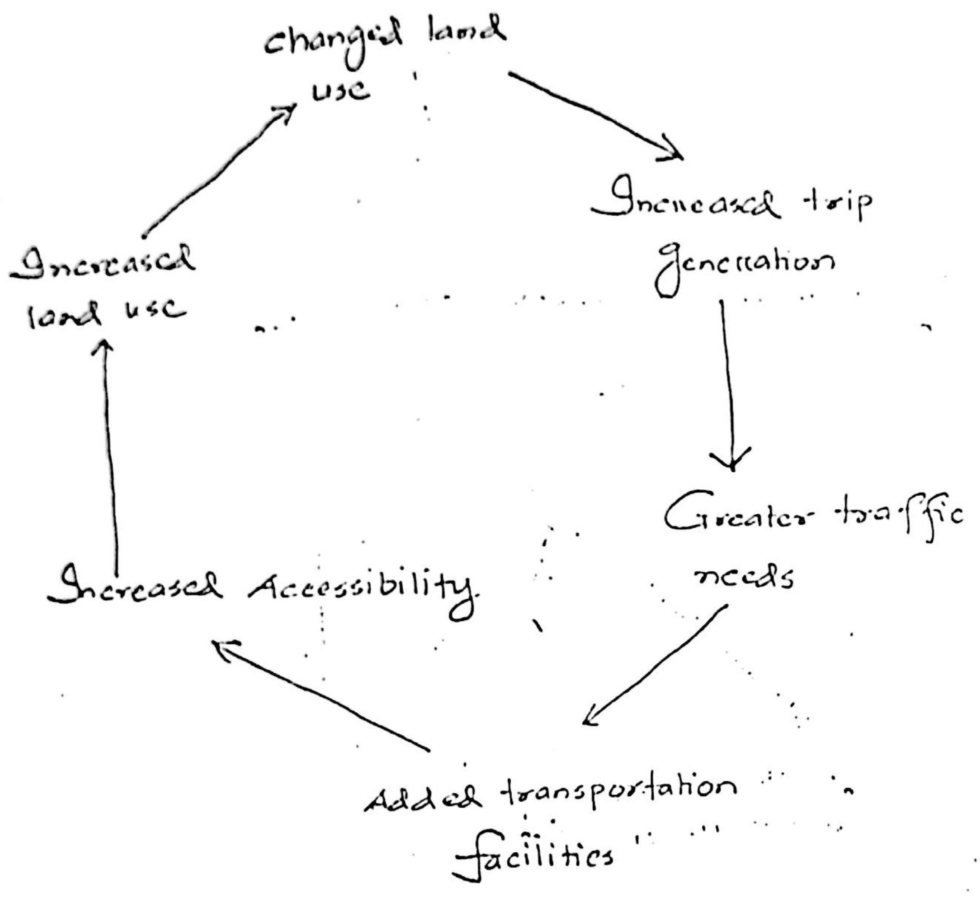
04.

Ques 09-10: Explain diagrammatically the basic movement to categorize travel pattern in planning areas?



Ques - 10-11 = Explain land use - transportation cycle



Transportation - land use cycle

change in land use may improved the facilities in the area and attracted individual. So trip rate increase, which requires greater number of traffics. So eventually to change in land use may cause to change in transport to change in transportation facilities. Because of greater or Improve in transportation facilities greater no. of people makes to these destination facilities which requires increasing land use and so do the facilit

Ques '10-11 :

SQ Given, $U_K = a_K - 0.25x_1 - 0.032x_2 - 0.015x_3 - 0.002x_4$

Determine: the trips taken by bus and auto by logit m...

Soln According to logit model,

$$P_{it} = \frac{e^{U_{it}}}{\Sigma e^{U_{jt}}} = \frac{e^{U_{bus}}}{e^{U_{bus}} + e^{U_{auto}}} = P_{bus}.$$

and, $$P_{auto} = \frac{e^{U_{auto}}}{e^{U_{bus}} + e^{U_{auto}}}$$

Now, $U_{auto} = -0.12 - 0.25 \times 5 - 0.032 * 0 - 0.015 * 20 - 0.002 * 1$

$= -1.87.$

$U_{bus} = -0.22 - 0.25 * 10 - 0.032 * 15 - 0.015 * 40 - 0.002 * 50$

$= -3.9.$

So, $$P_{bus} = \frac{e^{-3.9}}{e^{-3.9} + e^{-1.87}} = 0.116$$

$P_{auto} = 0.884$

No of trips taken by auto = 442

" " " " " Bus - 58

Ans

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Ques-'09-10:

$T_i = 450$ work trips.

From Gravity model,

$$T_{ij} = \frac{A_j F_{tij} K_{ij}}{\sum A_j F_{tij} K_{ij}} P_i$$

Here, $F_{tij} = c/t^n$.

Now, $\sum A_j F_{tij} K_{ij} = \sum (A_j * K_{ij}) \frac{c}{t_{ij}^n}$

$$= 750 \times \frac{c}{9^{0.6}} + 400 \times \frac{c}{5^{0.6}} + 300 \times \frac{c}{7^{0.6}}$$

$$= 446.32\,c$$

So, $T_{i1} = \frac{200.69c}{446.32c} \times 450 = 202.34 \simeq 202$

$T_{i2} = \frac{152.29c}{446.32c} \times 450 = 153.55 \simeq 154$

$T_{i3} = \frac{93.34c}{446.32c} \times 450 = 94.1 \simeq 94$

Ans.

Question '08-09

1(c) Trips no. that will increase in future

Trips/Household obtained from current trip making

Household size		1	2	3+
Household incom	Low	3.4	4.1	4.6
	Medium	3.7	4.5	4.9
	High	3.9	4.8	5.1

Forecasted no of trips in zone determined by multiplying the rate by no. of households

Household size		1	2	3+
House hold incom	Low	357	1127.5	1978
	medium	814	5499	11318.8
	High	351	576	1350

Total = 23871.3

≃ 23872

Ques '05-06

5(c) Given, no of trips = 33

Shopping Center	floor space	distance
1	184 ft² × 1000	8
2	215 ft² × 1000	4
3	86000 ft²	5

Trips from zone i to shopping center 1 = $\frac{184000/8^2}{\frac{184000}{8^2} + \frac{215000}{4^2} + \frac{86000}{5^2}} \times$ 33

= 4.8 ≃ 5 trips.

" " " i to " " 2 = $\frac{215/4^2}{\frac{184}{8^2} + \frac{215}{4^2} + \frac{86}{5^2}}$

= 22.45 ≃ 22 trips

" " " i to " " 3 = $\frac{86/5^2}{\frac{184}{8^2} + \frac{215}{4^2} + \frac{86}{5^2}}$

= 5.75 ≃ 6 trips.

GEOMETRIC DESIGN OF HIGHWAYS

* **Design controls and criteria:**

The elements of design are largely influenced by the design conts and engineering criteria and project specific objectives. Such factors nclude the followings:-

- Traffic safety consideration.
- functional classification and of the roadway
- Projected traffic volume and composition.
- Required design speed.
- Multimodal needs of surrounding community.
- Topography of surrounding land.
- capital costs for. construction
- Agency funding mechanism.
- Human sensory capacities of roadway users.
- vehicle size and performance characteristics
- public involvement, review and comment
- Environmental consideration
- Right - of - way impacts and costs.

esign speed : '09-10

- The engineer should select a design speeds for assuming the ? **users travel** at desired speed for specific facility.
- other factors influencing the selection of desired speed including n, volm of traffic and composition, costs of right - of - w. aesthetical consideration.
- Design speed ranges from 15 to 75 mph. and intermedi are choosen in increments of 5mph.

— where [illegible]

substantial length of highway to assure the consistency of roadway features.

— where change in terrain or other conditions dictate to change the speed, these change should be made over a sufficient distance to permit the driver to change speed gradually.

* Design Vehicle : '09-10

— The dimensions of motor vehicle that utilize the proposed facility influence the design of roadway project. The width of the vehicle naturally affects the the width of the lane. The vehicle length has a bearing on roadway capacity and affects the turning radius. The height of the vehicle affects the clearance of the structure. The weight of the vehicle affects the structural design of roadway.

— Vehicle performance has a considerable impact on designing of the highway. Acceleration and deceleration rates are important parameter to calculate the several numerical equation. An obvious consideration when designing a two-lane road is an evaluation of slow-down speed. Factors affecting the slow-down speed is the steepness of the roadway upgrade and the total length of the upgrade.

* Limited Access - Highway:

Defn:

A Limited access highway may be defined as a highway street especially designed from through traffic where motori and owners of abutting properties have only restricted right of access.

Benefits:

- Improved highway capacity.
- Improved highway speed.
- Improve safety.

Controlling of Limited access:

- limiting the number of connection to and from highway
- facilitiing the flow of traffic by separating cross traffic with over pass and under pass.
- Eliminating or restricting direct access of by owners of the abutting properties using frontage roads.

Consideration:

The design of limited access should provide adequate of right-of-way, adequate landscaping, prohibition of out advertisement, control of abutting service facilities.

* Pavement Crowns:

Purpose:

- for drainage purpose

limits:

- Present days high-type pavement with good quality control of drainage 1/8" per foot.

- Low crowns are satisfactory when:-

(i) little or no settlement in the pavement is expected

(ii) Drainage system is of sufficient capacity to remove the water from the traffic lane.

- when four or more lanes are used, it is desirable to use higher crown on the outer lane to expedite the flow water from the pavement to the gutter.

Curbs:

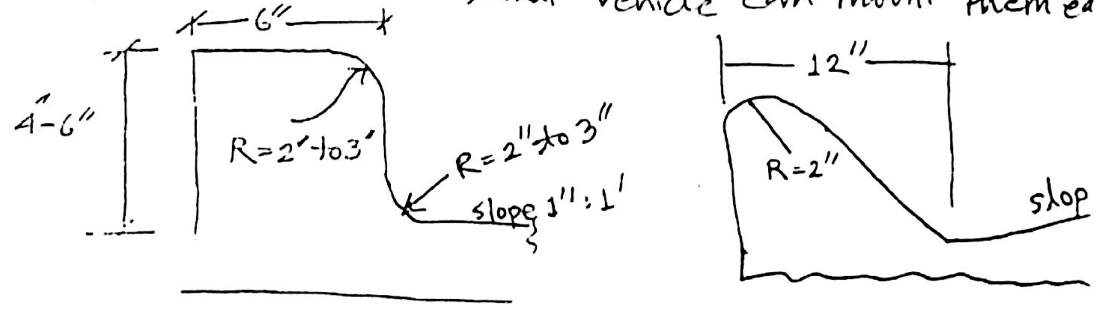
two major types:-

(i) mountainable curb.

(ii) Verticle barrier curb.

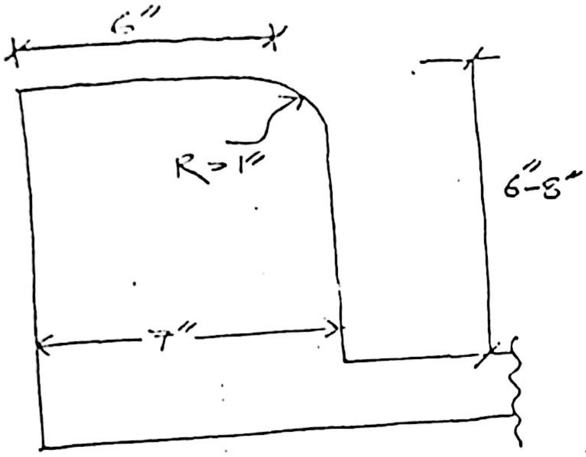
* ~~Mountainable~~ Mountable curb:

- used when no sidewalks are provided
- Low in height
- Constructed with a verticle flattened angle
- face of the curb should not be steeper than 4 so that vehicle can mount them ea



Vertiale Barrier Curb:

- Curbs at parking and adjacent to side walk.
- Height 6"-8"
- face of the curb nearly verticle.



- Factors affecting the height of the curb:
  - height of the curb should be such that to open the door of the passenger-cars with sufficient clearence and to facilitate car fenders and bumpers.
  - storm water drainage and the to accomodate curb will also affect the shape and height of the curb.
  - From a pedestrian's point of view the height should imited to one step height.

07/09 Shoulders: 09-10-11

purpose:

- safe operation.
- develop full capacity of the road.
- increase the effective lane width as the drivers closer to the edge of the roadway.
- Permit and encourage the traffic to leave travel lane while stopping.
- Greater the traffic volm, the greater is the likely to be used in emergency purpose.

limits:

Highway type	desired value	limiting value
(I) High speed highway	12′	10′
(II) Low-type highway	6-8′	4′
(III) In terrain when guard rails are required.	Additional 2′	—

* Guard rails:

Guard rails are provided :-

- where fills are about 8ft in height
- side walks shoulder slopes are greater than 1V:4H.
- location where there is a change in allignment.
- Where greater reduction in speed is necessary.
- locations with deep ditch, banks and other right-of-way limitation, it is necessary to provide steepness in side slope and use guard rail.

Types of guard rail

three types :- (I) W - Beam guard rail
(II) Cable guard rail
(III) Box beam guard rail.

* Right - of - way :

- The portion which is fully used.
- The portion which is required for us.

A wide section of right - of - way provides :-

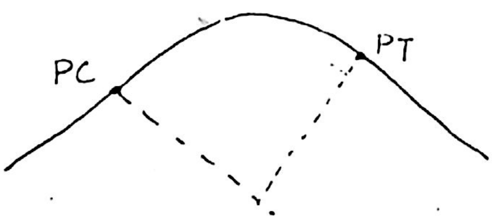
(I) Safer highway.
(II) gentle rounded slope
(III) Low maintenance cost

Sufficient right - of - way should be acquired to :-

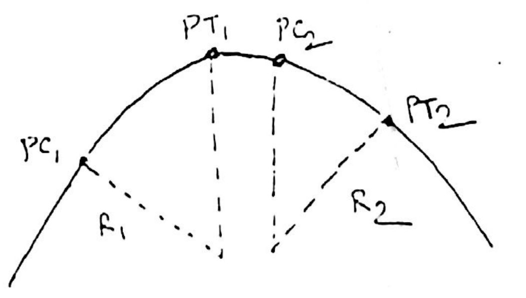
(I) avoid the expense of purchasing developed property
(II) Removal of encroachment.

- Types of super elevation curves :

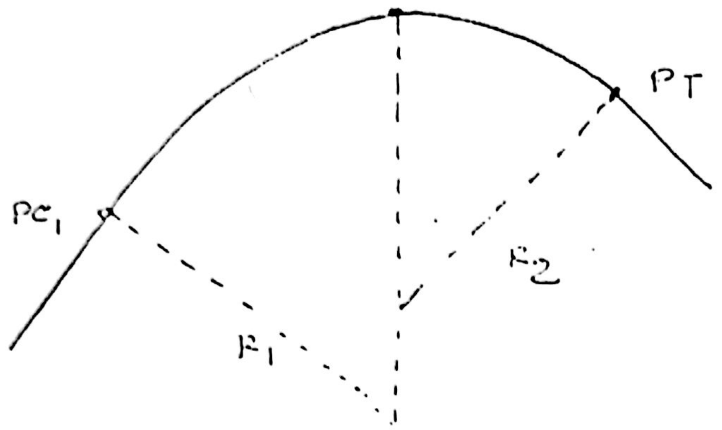
four types :- (I) Simple Horizontal curve
(II) Broken back curve.
(III) Compound curve
(IV) Rerse curve Reverse :- (I) with tangent
(II) without tangent



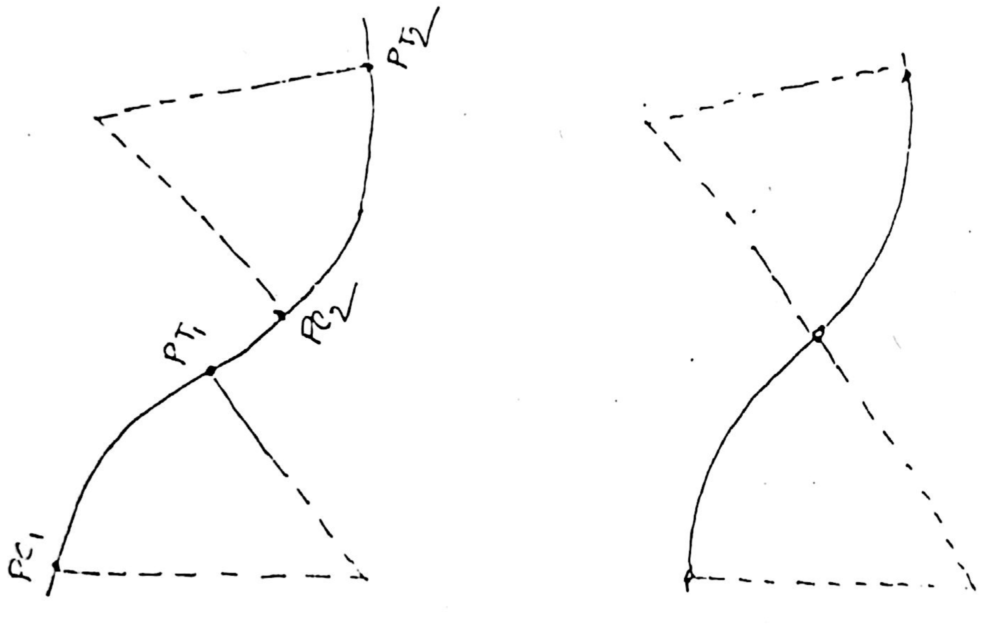
(a) Simple Horizontal Curve



(b) Broken Back curve



(c) Compound curve



(i) With tangent (ii) Without tangent

(d) Reverse curve

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* Importance of super elevation:

- To reduce the centrifugal force
- To reduce the tendency of slip.
- To attain desired speed.

* Attainment of super elevation

The transition from tangent, normal crown section to a curve super elevation section must be accomplished without any appreciat reduction in speed and in such a manner to ensure the safety and comfort to the occupants of traveling the vehicle

In order to attain the change, the curved section should tilted and banked as a whole to provide the super elevation cr section required speed. Four methods are commonly used to attain super elevation transitions:-

01. The tilting usually is accomplished by rotating the cros section about the central line axis. The effect of this rotation to lower the inside edge at the sametime to raise the outside edge without changing the central line grade.

02. Second method to rotate about the inner edge

03. Third method to rotate normal cross section abou the outer edge.

04. fourth method to rotate straight cross section abou he outer edge.

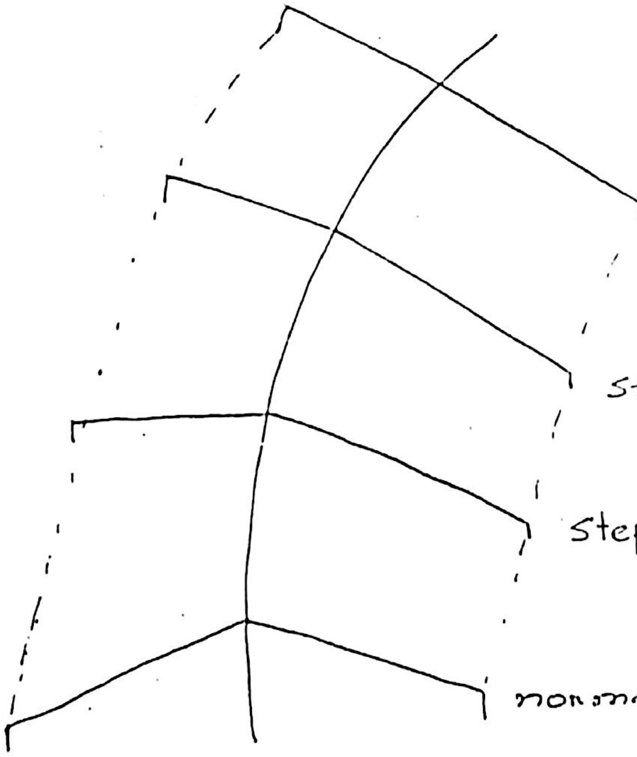
rocess:

The process to attain the super-elevation by first method given below:-

step 01: changing the section from CL to the outside edge

step 02: raise the outer edge to an amount half of desired superelevation and at the same time, lower the inside edge and put the whole section in one inclined plane.

step 03: Continue the rotation about CL until the full superelevation is reached.



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* Diagrammatic representation of attaining super-elevation

* Widening of curves:

major reason:

As a vehicle turns at the curve the rear wheels follow the front wheel on shorter radius. and this effects increasing the width of the vehicle in relation the lane width. Studies of drivers traversing curves have shown that the tendency to drive a curved path longer than the actual path curve, shiffting the vehicles right at right-turning curves and left on left turning curves. Thus the right turning curves the vehicle shifts toward inside edge on pvt. pavement Thus the curves need widening. This widening are influenced by factors like:-

(I) width of pvt on tangent
(II) Speed of vehicle
(III) Horizontal curve radius.

Minor Reasons:

Other factors affecting widening on curves:-

- To attain slip.
- more place is required at curve physically.

- rear wheel follow the front wheel on shorter redius.
- tendemcy to drive a curved path longer than the actual path curve.
- shift vehicle righ at right turn
  left at left turn
- width of pavement on tangent
- speed of vehicle.
- Horizontal curve radius.
- to attain slip
- more place is req at curve physically.

Sight Distance

Safe highways must be designed to give drivers a suff distance of clear vision ahead so that they can avoid hitting unexpected obstacles and passing the slower vehicle without danger.

Sight distance is length of highway that is visible ahead a vehicle of driver. In a roadway three types of sight distance should be considered:-

01. Stopping sight Distance
02. Passing sight distance
03. Decision sight distance

Stopping Sight distance

Stopping sight distance is the minimum distance ~~that~~ ~~a vehicle~~ required to stop a vehicle travelling near the design speed before it reaches a stationary object in vehicle's path

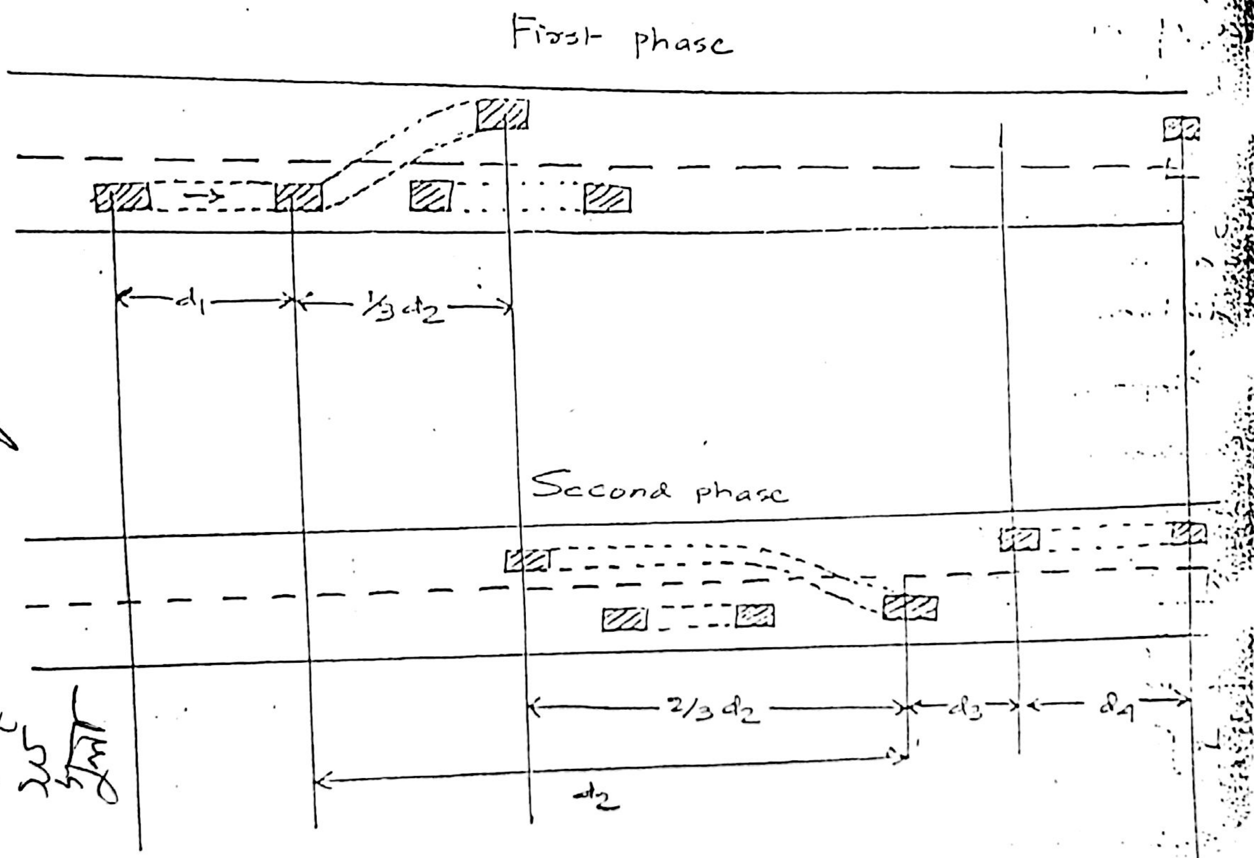
Passing Sight Distance:

When the sight is long enough to enable a vehicle to overt and pass another vehicle in a two-lane highway without interfence from opposite vehicles this sight distance is known as passing sight distance.

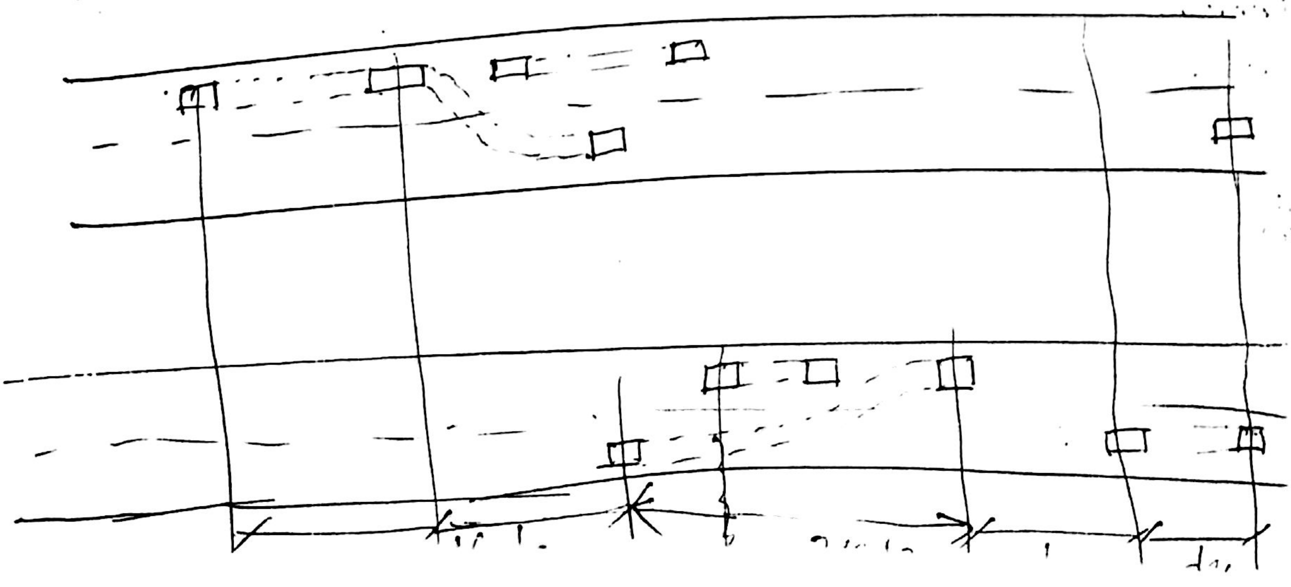
Decision Sight Distance

Sometimes the driver may encounter an unexpected road feature. The sight that is required for a driver to make decision and execute require manuevers at complex location known as decision Sight Distance.

+ Passing Sight Distance



Minimum passing sight distance = distance traveled during perception and reaction time and during the initial acceleration to the point where the vehicle will turn into the opposite direction (d1) + the distance travell when the passing vehicle occupied the left lane + distance between the passing vehicle manuever (d3) + The distance traveled by the oncoming vehicle from opposite direction.



Mathematical Problem

6(c) Question ~~09-10~~ 10-11

Given, Avg. speed of the passing vehicle = 51mph

Avg. speed of the passed vehicle = 41mph

time of preliminary delay of passing vehicle = 4sec

Avg. acceleration rate for passing vehicle = 1.43mph/s

Time passing vehicle occupies the opposite lane = 10sec

safe clearance distance = 180 ft

Now, $d_1 = 1.47\, t_1 \left(v - m + \frac{a t_1}{2}\right)$ $m = (51-41) = 10$ mph

$= 1.47 * 4 \left(51 - 10 + \frac{1.43 \times 4}{2}\right)$ $t_1 = 4$ sec

$= 257.8968$ ft

$d_2 = 1.47\, v t_2$

$= 1.47 * 51 * 10 = 749.7$ ft

d_3 = safe clearance distance

$= 180$ ft

$d_4 = 2/3\, d_2 = 2/3 * 749.7 = 499.8$ ft

min^m^ passing distance $= (257.896 + 749.7 + 180 + 499.8)$ ft

$= 1687.396$ ft

Que: '07-08 7(c)

Given, v = velocity of vehicle in mph when brake is applied = 65 mph

g = percentage of grade = $3/100$

f = co-efficient of friction b/w tires and pvt = 0.2.

So, $d = \frac{v^2}{30(f \pm g)} = \frac{65^2}{30(.29 + 0.03)} = 440.1 < 500'$

Driver will be able to stop the car before hitting the obstruction.

See sheet

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