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Section # A

Subject # Highway & traffic Engineering

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Department # Civil Engineering

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Exam # Mid Term

HIGHWAY AND TRAFFIC ENGINEERING

Q1: Keeping in view different modes of Transportation compare railways and highways.

Ans) The transportation of goods and people for short distances can be speedily and easily done by highways, however for long distances transportation by railways track are safe, economical and convenient.

HIGHWAYS	RAILWAYS
1) Roules consists of suitable pavement of specified width.	1) Route consists of pair of steel rails laid parallel.
2) In Highways, routes are meant for movement of different types of traffic such as buses, cars, trucks etc.	2) Railway routes are meant only for movement of trains.
3) The highway, routes require more width of right of way.	3) The railway routes require less width of right of ways.
4) The required strength of roadways is less.	4) The required strength of railways tracks is more.
5) The construction and maintenance cost of highways is less.	5) Railways construction and maintenance cost is high.
6) The load handling capacity of highways vehicle is less and that too at low speed.	6) Load handling capacity of railways vehicle is more and that too at high speed.

Q2) You are a Transportation engineer. You have been tasked to conduct office study as a priliminary step for design of new highway. What reference material you will study and what data you will extract?

Ans: If, I am tasked to conduct office study as a primliminary step then during the prdiminary phase of the study; the positions of the feasible routes are set as closely as possible by:

1) Establishing all the control points.
2) Determining preliminary vertical and horizontal alignmats for each.

→ Priliminary alignments are used to evaluate the economic and environmental feasibility of the alternative routes.

→ Economic Evaluation of each alternative route is carried out to determine the future effect of investing the resources necessary to construct a highway.

Factors considered in Economic Evaluation:-

1) Road user costs
2) Construction costs
3) Maintenance costs
4) Road user benefits
5) Road user dis-benefits - such as adverse impacts due to dislocation of families, businesses and so-forth.

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Results of economic evaluation of the feasible routes -

1) Provide information on the economic resources that will be gained or lost if a particular location is selected.
2) Aid the policy makers in determining whether the highway should be built and if so, what type of highway it should be.

Environmental Evaluation:

1) Highway construction at any location - significant impact on surroundings
2) A highway - an integral part of the local environment.
3) Environment includes plants, animals and human communities and encompasses social, physical, natural, and man made variables.
4) These variables are interrelated in a manner that maintains equilibrium and sustains the lifestyle of the different communities.
5) The construction of a highway at a given location may result in significant changes in one or more variables, which in turn may offset the equilibrium and results in significant adverse effects on the environment.
6) This may lead to a reduction of the quality of life of the animals and human communities.
7) Essential to evaluate environmental impact of alignment selected

8) In cases environmental impact study (EIS) is required, it is conducted at this stage to determine the environmental impact of each alternative route.

9) EIS will determine the negative and/or positive effects the highway facility will have on the environment.

Example

→ At grade freeway construction, urban area may result in an unacceptable noise level for the residents (negative impact).

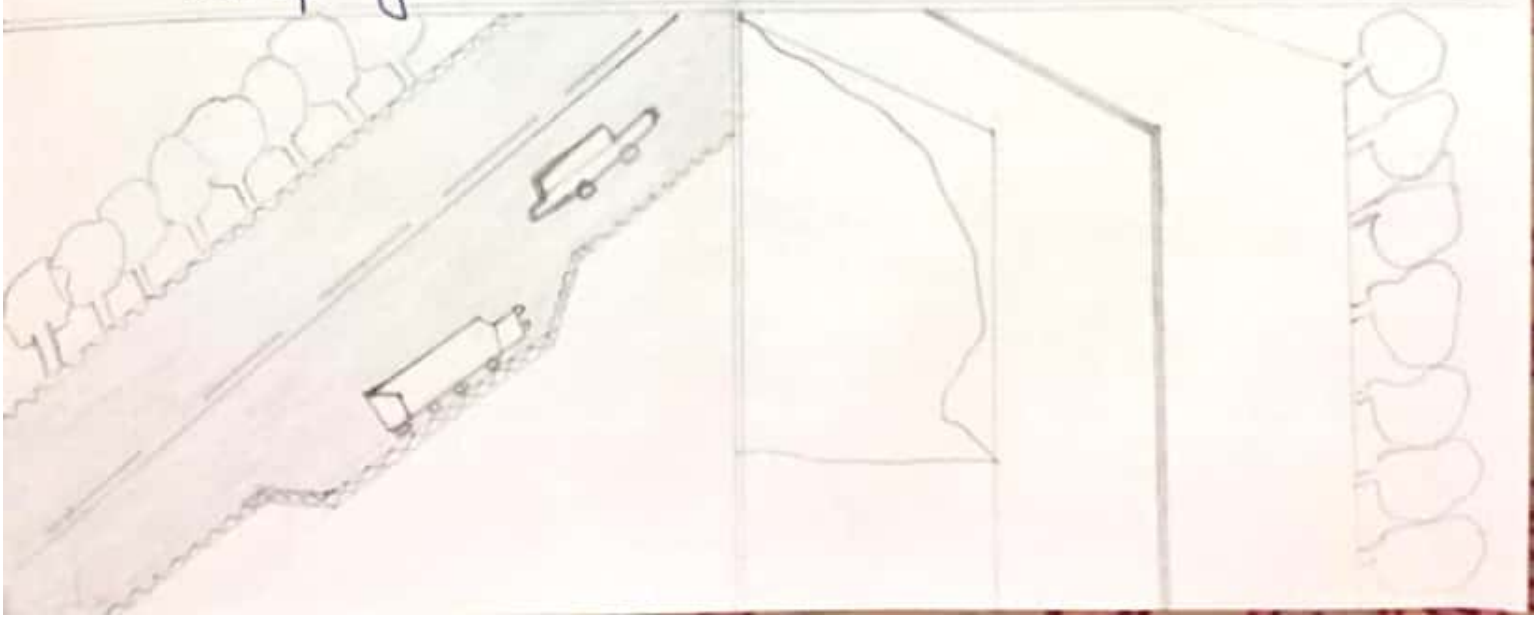
→ Highway facility may be located so that it provides better access to jobs and recreation centers. (positive impacts).

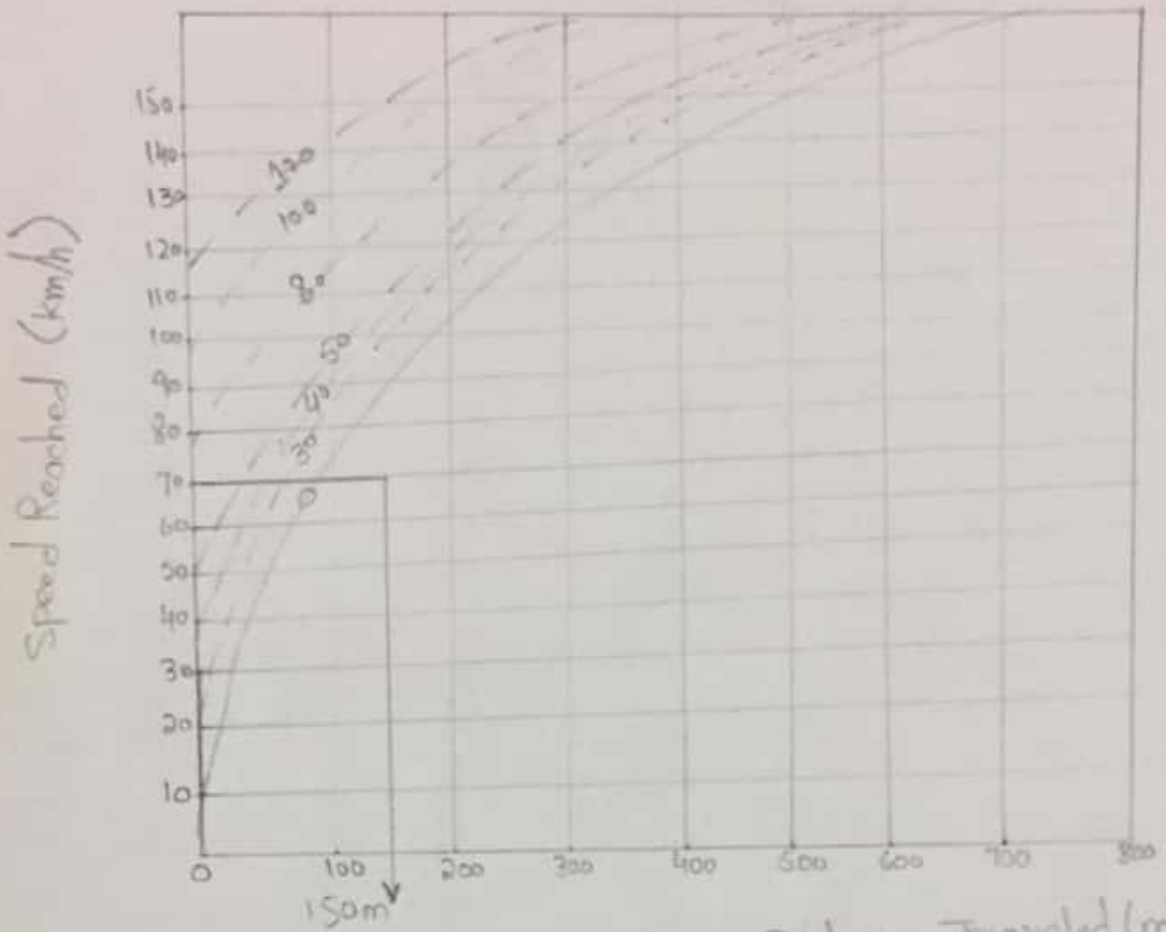
Q3) What is importance of vehicle performance in highway design?

Ans: Acceleration and deceleration rates of vehicles are often critical parameters in determining highway design.

These rates often govern the dimensions of such design features:

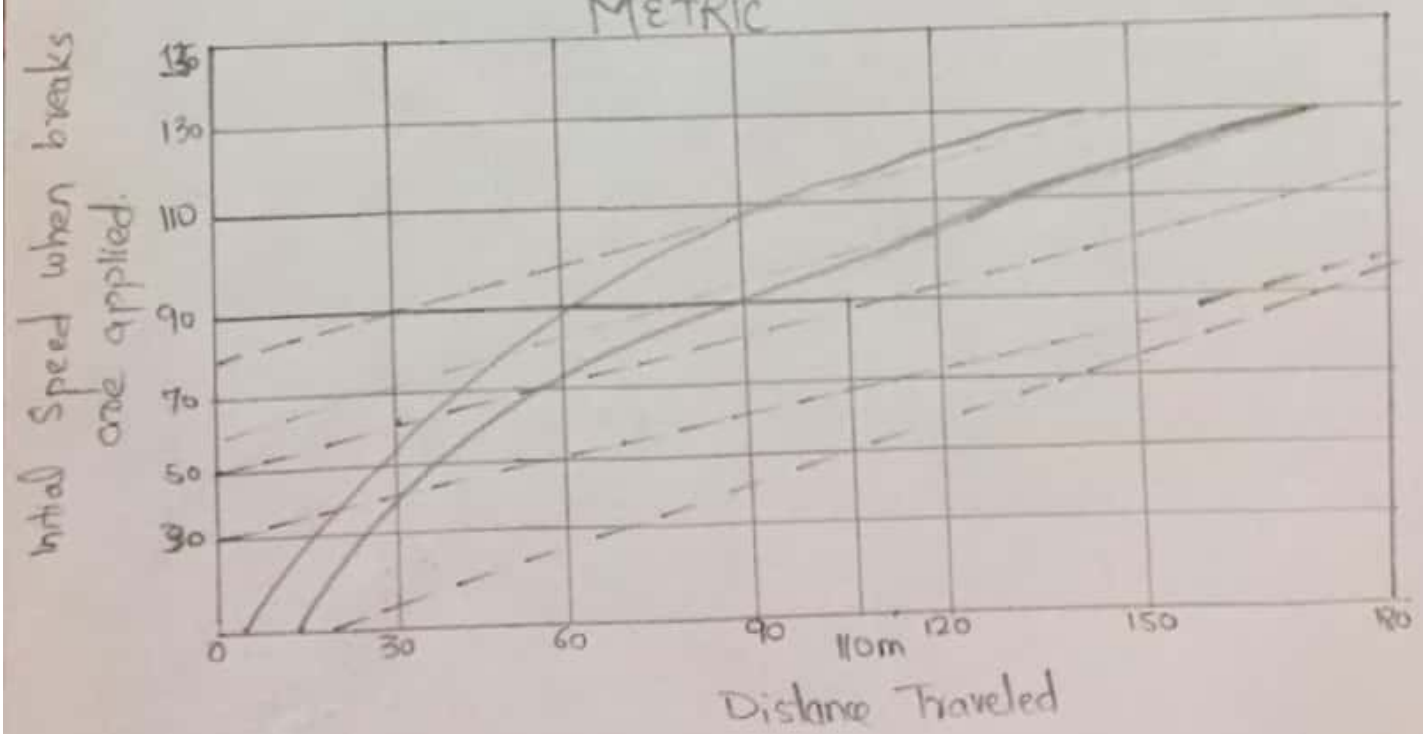
1) Freeway ramps.
2) Climbing or passing lanes.
3) Turnout bays for buses
4) Acceleration and decderation lanes.
5) Highway alignment (adequate passing and stopping sight distance).
6) Determine the need for truck climbing lanes (steep grade).





Passenger Cars - Distance Traveled (m)

Acceleration of Passenger Cars, Level Conditions.



Deceleration Distances for Passenger Vehicle Approaching Intersections.

Q4. Write short note on Directional distribution in design of highway?

Ans) The directional design hour volume (DDHV) is the one way volume in the predominant direction of travel in the design hour, expressed as a percentage of the two way DHV. For rural and suburban roads, the directional distribution factor (D) ranges from 55-80%.

→ Highways must be designed to adequately serve the peak-hour traffic volume in the peak direction of flow.

→ Total hourly traffic in both directions is used to design <u>two-lane roads</u>.

→ In the design of highways with more than two lanes & on two-lane roads where important intersections are encountered or where additional lanes are to be provided later, knowledge of the hourly traffic volume for each direction of travel is essential. Directional traffic is used for multilane roads and streets.

→ Typically, one direction contributes by 55-70% in total traffic, although occassionally 80% is observed.

→ Directional Distribution - Directional Design hourly volumes DDHV - ADTs are converted to a peak-hour volume in the peak direction of flow.

$$DDHV = AADT * K_{(Peakhr)} * D_{(Peakhr-flow)}$$

Q5) Explain broad classification of surface distress modes?

Surface Distress

"Any indication of poor or unfavorable pavement performance or signs of impending failure; any unsatisfactory performance of a pavement short of failure".

Surface distress modes can be broadly classified into following three groups.

1) **Fracture:-** This could be in the form of cracking (in flexible or rigid pavements) or spalling resulting from such things as excessive loading, fatigue, thermal changes, moisture etc.

2) **Distortion:-** This is in the form of deformation e.g rutting, corrugation and shoving, which can result from creep, densification, swelling, or frost action.

3) **Disintegration:-** This is in the form of stripping, raveling or spalling which can result from loss of bonding, chemical reactivity, traffic abrasion, aggregate degradation, poor consolidation/compaction or binder aging.

Q6. Explain Alligator cracking, block cracking, Longitudinal cracking and Transverse cracking.

1) **Alligator Cracking:**

A series of interconnected cracks caused by fatigue failure of the HMA surface under repeated traffic loading. As the number and magnitude of loads becomes too great, longitudinal cracks begin to form (usually in the wheelpaths). After repeated loading these longitudinal cracks connect forming many-sided sharp-angled pieces that develop into a pattern resembling the back of an alligator or crocodile.

Problem: Roughness; indicator of structural failure, cracks allow moisture infiltration into the base and subgrade, eventually results in potholes and pavement disintegration if not treated.

Problem causes:

1) Inadequate structural support for the given loading.
2) Decrease in pavement bad supporting characteristics, probably the most common reason is loss of base.
3) Increase in loading.
4) Poor construction.
5) Inadequate structural design.

2) Block Cracking:

Interconnected cracks that divide the pavement up into rectangular pieces. Blocks range in size from approximately $1 ft^2$ to $100 ft^2$. Larger blocks are generally classified as longitudinal and transverse cracking. Block cracking normally occurs over a large portion of pavement area but sometimes will occur only in non-traffic area.

Problem : Allows moisture infiltration, roughness.

Possible causes: HMA shrinkage and daily temperature cycling. Typically caused by an inability of asphalt binder to expand and contract with temperature cycles because of:

- Asphalt binder aging
- Poor choice of asphalt binder in the mix design

Repair: strategies depends upon the severity and extent of the block cracking.

- Low severity cracks. ($< 1/2$ inch wide). Crack seal to prevent 1) entry of moisture into the subgrade through the cracks and 2) further ravelling of the cracks edges
- High severity cracks ($> 1/2$ inch wide and cracks with raveled edges). Remove and replace the cracked pavement layer with an overlay.

3) Longitudinal Cracking:

Cracks parallel to the pavements centerline or laydown direction. Usually a type of fatigue cracking.

Problem. Allows moisture infiltration, roughness, indicates possible onset of fatigue cracking and structural failure.

Problem Causes:

1) Poor joint construction or location. Joints are generally the least dense areas of a pavement. Therefore, they should be constructed outside of the wheelpath so that they are only infrequently loaded. Joints in the wheelpath will general fail prematurely.
2) A reflective crack from an underlying (not including joint reflection cracking).
3) HMA fatigue.
4) Top-down cracking.

Repair: Strategies depend upon the severity & extent of cracking.

- Low severity cracks (< ½ inch wide and infrequent cracks). Crack seal to prevent 1) entry of moisture into the subgrade through the cracks and 2) further ravelling of the crack edges.
- High severity cracks (> ½ inch wide & numerous cracks). Remove and replace the cracked pavement layer with an overlay.

4) Transverse Cracking:

Cracks perpendicular to the pavements centerline or lay down direction. Usually a type of thermal cracking.

Problem: Allows moisture infiltration, roughness.

Possible Causes:

1) Shrinkage of the HMA surface due to low temp or asphalt binder hardening.
2) Reflective crack caused by cracks beneath the surface HMA layer.
3) Top-down cracking.

Repair: strategies depend upon severity and extent of the cracking.

- HMA can provide years of satisfactory service after developing small cracks if they are kept sealed.
- Remove and replace the cracked pavement layer with an overlay.