TRAFFIC ENGINEERING

DESIGN SPEED

Definition

According to AASHTO "It is the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern"

Factors Affecting Design Speed

Following are the factors, which affect the design speed:

- Type of road
- Importance of road
- Surface characteristics of road
- Type and intensity of traffic
- Road geometric and topography of the area
- Weather conditions (wind speed, rainfall etc)
- Sight distance.

Generally, the design speeds of highways are chosen by administrative decision. Consequently, the design speed for a particular type of highway will vary from country to country.

Rural Roads

The Department of transport's recommendations with regard to design speed recognizes that vehicle speeds vary according to the impression of constraint that the mainline road alignment and layouts impart to the driver. Consequently, the Department utilizes a graphical procedure, which is based on measurements of this constraint when selecting mainline design speed for rural roads.

The table below shows typical design speeds for both mainline and connector carriageways:

Road type	Design speed (km/h)	Speed limit
Motorways and dual carriageways	120	112
Single carriageways derestricted	100	96
Others	85,70	-------

Connector type	Design speed	
	Desirable minimum (km/h)	Absolute minimum (km/h)
Link roads	85	70
Slip roads	70	60

In practice, the majority of vehicles speeds on dual and single carriageway highways are generally less than the design speed (120 km/h), and vehicle operating behavior is normally in line with the conditions assumed in the formulation of the speed design concept.

Design speeds lower than 120 km/h are often applied to single carriageways in order to keep construction costs within certain limits. There is a danger in this philosophy, since the drivers will obviously accept lower values. At difficult locations, repeated studies have shown that they do not adjust their speeds to the importance of the facility. Instead, they endeavor to operate at speeds consistent with the traffic on the facility and their view of its physical limitations.

For a highway that is designed in the range 80-120 km/h, operating speeds tend to vary according to the actual speed standard of individual alignment features; thus they may often be in excess of the design speed at particular locations. Typically, however, operating speeds rarely exceeds the speed standards for individual elements of horizontal alignment, although they may be greater for vertical alignment elements.

When the highway has a design speed less than about 80 km/h, actual speeds again vary considerably according to the alignment conditions; and generally they are greater than the design speed. In this situation, it is quite invalid to consider design speeds as reflective in any real way of drivers speed behavior.

Lower design speeds, e.g. 40 or 50 km/h, are rarely used now-a-days as a basis for the design of any significant length of rural highway; rather, they may be used to design isolated curves under severely constrained conditions. Their applications generally results from an attempt to fit the most liberal curves permitted by the terrain constraints.

When designing a substantial length of highway, it is obviously desirable that a constant design speed be used. However, this may not always be feasible because of topographical or other physical limitations. Where these occur, a change in design speed should not be introduced abruptly, but instead a transition stretch of adequate length should be inserted. Within this stretch, drivers should be encouraged to reduce speed gradually by means of adequate signing notifications.

Urban Roads

The design speed of mainline carriageways of an urban motorway should ideally be as high as possible. However, the basic consideration in choosing the design speed of the higher qualities urban roads should be greater than the running speed desired for maximum flow during the peak demand periods.

Safety considerations, influenced by the greater frequency of intersections on urban roads, combined with the greater (and more expensive) land required by high speed highways, strongly suggests that major highways in urban areas should be designed to lower speed standards than equivalent highways in rural areas.

From practical aspect, it should also be • appreciated that speed limits are more readily imposed and accepted in urban areas, so that motorists who might wish to travel in excess of the speed standard for the road during off peak hours are more easily regulated.

Design speeds for lower quality urban roads are generally limited by the place of these roads in the hierarchical highway system, which in turn is influenced by safety, cost and environmental concerns.

In British practice, the design speeds for urban roads are normally selected with reference to the speed limits envisaged for road, so as to permit small margin for speeds in excess of the speed limit as shown in table below. The minimum design speed used on primary distributors is 70 km/h.

Design Speed	Speed limit
60	48
70	64
85	80
100	96

Table shows typical control speeds fro main line carriageways for urban roads in km/h.

Connector type	Design speed	
	Desirable minimum	Absolute minimum
Link roads	70	50
Slip roads	60	50

Table shows typical control speeds for connector roads to motorways and dual carriageways for urban roads in (km/h).

TRAFFIC ESTIMATION

Traffic estimation means the calculation of or collection of the traffic data for the reconstruction or building a new road or highway.

- This type of traffic data includes;
- Traffic Flow or Traffic volume
- Traffic Speeds
- Travel time
- Traffic Densities
- Occupancies
- Headways and gaps

The basic type of traffic estimates is the **volumes or flows**, which governs the design of a roadway.

Traffic volumes

Traffic flow on a highway is measured by the number of vehicles passing a particular station during a given interval of time. In many instances, traffic is stated as "Average Annual Daily Traffic," commonly called the AADT. Again, volume may be stated on an hourly basis, such as the "hourly observed traffic volume," which is commonly used for design purposes.

Traffic flow at a given location depends on numerous factors peculiar to that site. As would be expected, it varies by;

- Hours of the day
- Days of the week and
- Months of the year

Likewise, its character changes; e.g., the percentage and kind of trucks are a function both of time of day and the contributing area.

Traffic Flow Pattern Rural areas

Fig (a) shows traffic flow for a representative major rural highway.

Among its characteristics are;

- Balanced movement in two directions throughout the day
- The absence of sharp morning and afternoon peaks; and
- A relatively uniform volume of heavy trucks

Greater daily volumes are indicated for the weekends, with smallest flow midweek.

Fig. a-1. Average annual Traffic by hours of the day

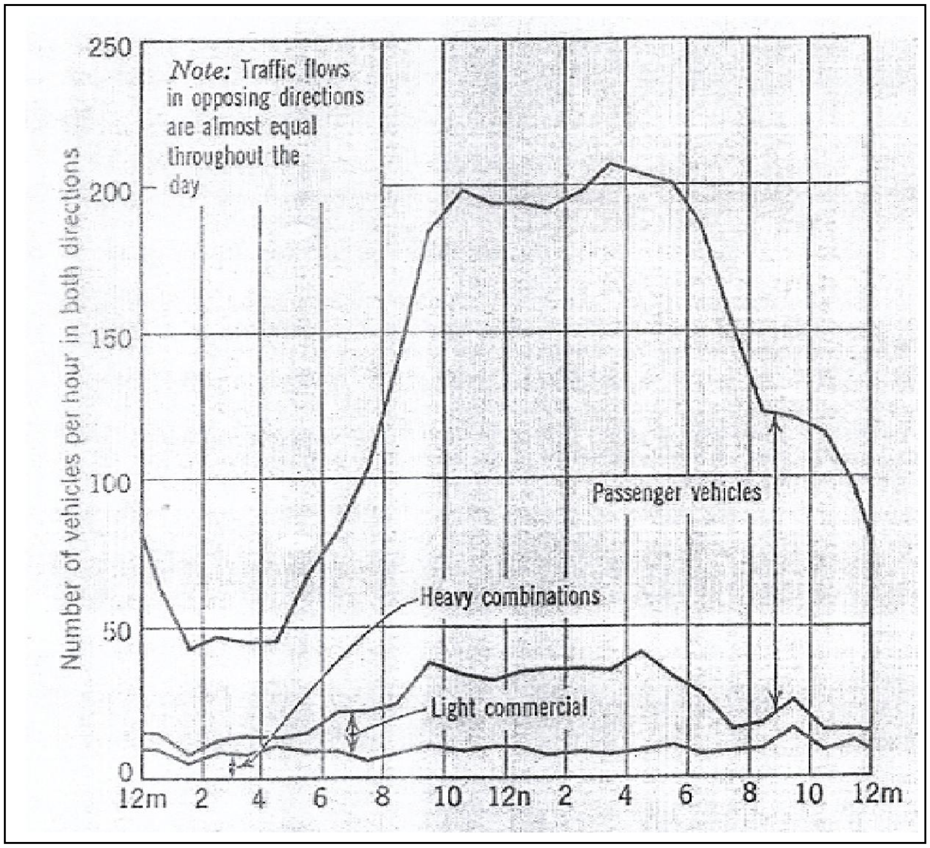
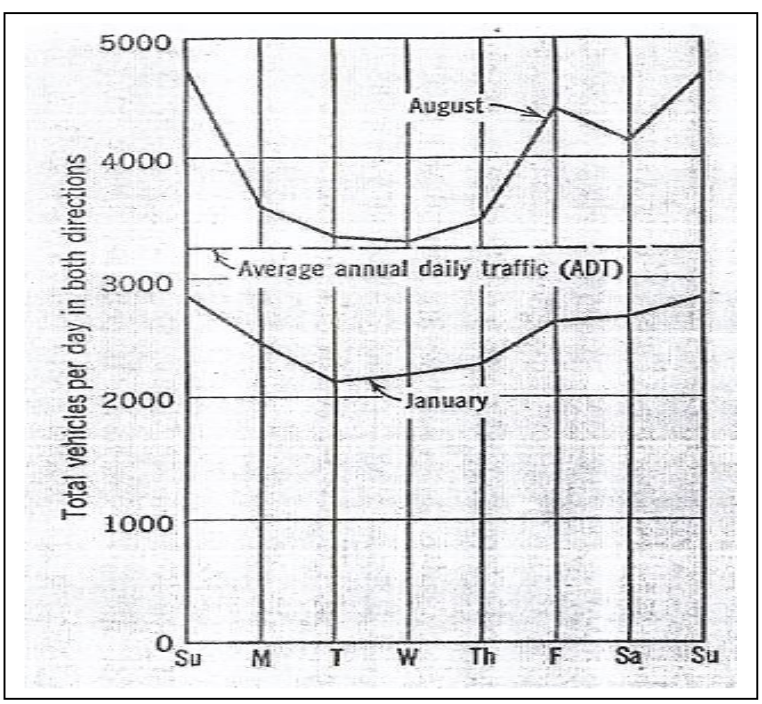


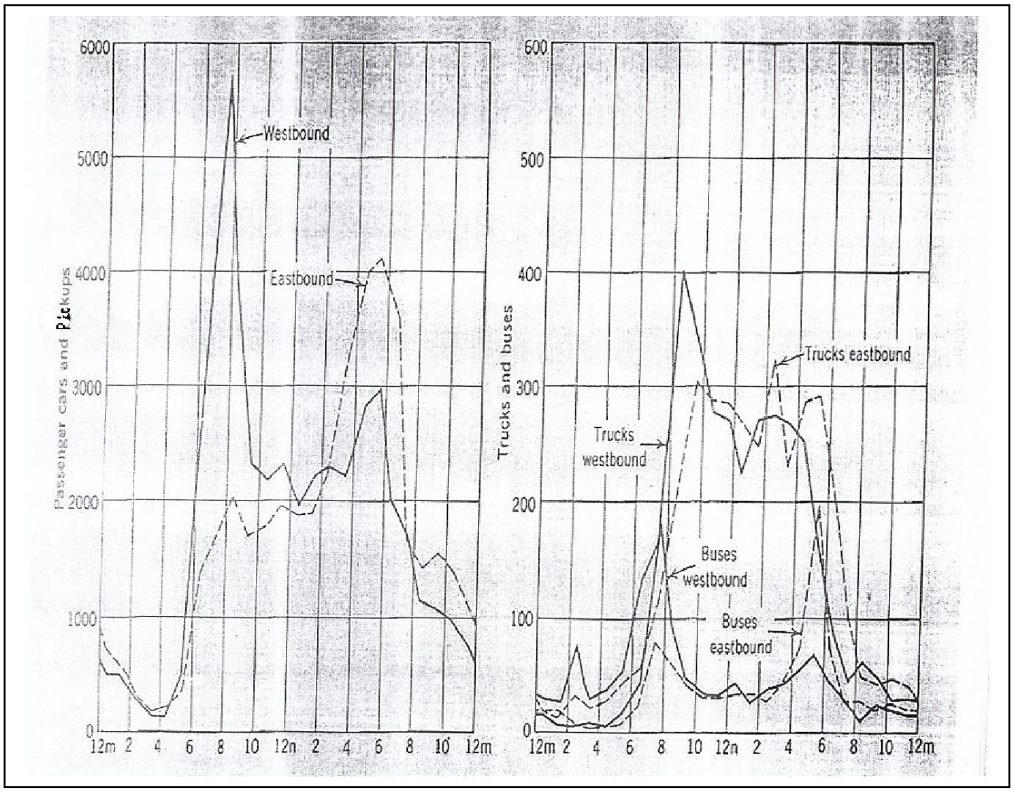
Fig. a-2. Average daily flow in high and low months



Traffic Flow Pattern Urban areas

Fig (b) shows the flow on a major urban traffic artery. Heavy volumes of automobiles and buses carrying commuters move westbound in the morning and reverse their direction in afternoon.
There is a decided falloff in both directions in the middle of the day. In contrast, heavy trucks flow generally begins late in the mornings, are relatively constant through the midday period, and falloff somewhat in the late after afternoon. During the evening commuter period, the bridge is jammed with eastbound passenger car, trucks, and buses. It operates at capacity for some three hours.

Fig. (b). Rate of traffic flow in vehicle per hour on the San Francisco-Auckland bay bridge,



In contrast morning peak is much higher and sharper, since the absence of trucks makes room for added passenger cars. It is not economically sound to have a highway congestion-free every hour throughout the year. However it has been established that for many hours each year the traffic volume approaches that of the thirtieth heaviest hour, which is the hourly volume exceeded only 29 hours throughout the year. This is demonstrated for rural and urban situations by fig (c) and fig (d) respectively.

As shown in fig (c) and fig (d) the ratio between thirtieth hour volume and AADT is far from constant for all roads; actually, recorded extremes have ranged from 8 to 38%. For rural locations, irreducible minimum appears to be about 9.5%; lower percentage would be definite indication that traffic desires are being suppressed. There has been evidence in the past to indicate that the ratio for individual stations remained constant throughout the year, but recent studies do not entirely support this view.

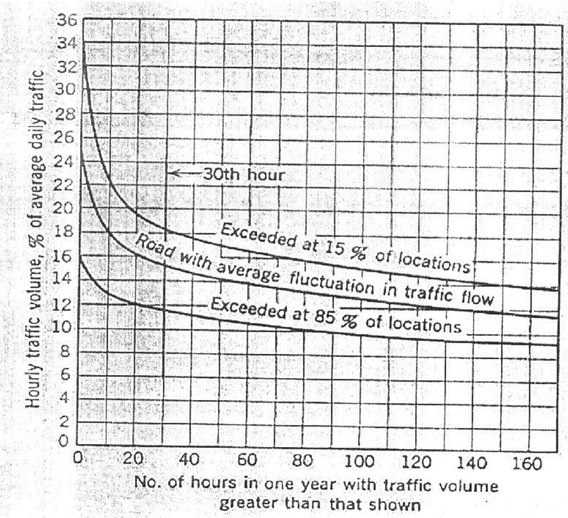


fig (c) :-

Relationship between peak hourly flows and annual average daily traffic on main rural highways. (Courtesy U. S. Bureau of Public Roads)

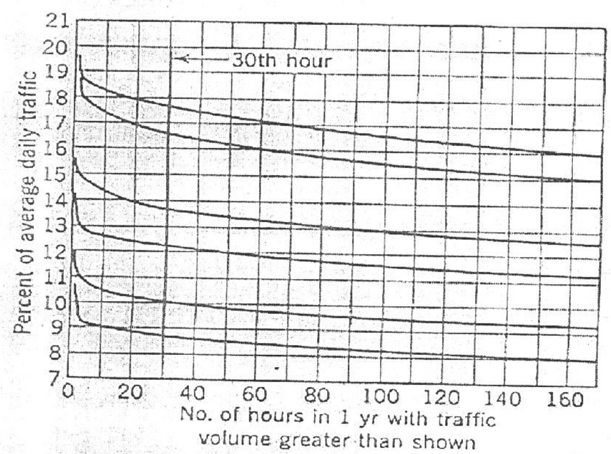


fig (d) :-

Relationship between peak-hour flows and average daily traffic on city streets. Data from six locations in Cincinnati, Ohio. (After A. M. Vorhees, *HRB Bulletin 203*)

Estimating future traffic volumes

Many relatively new highways are now overcrowded because they were designed for traffic volumes far lower than those that have actually developed. All sorts of explanations have been offered, but they might be summed in the statement that "improved highways breed a traffic spiral that leads to their obsolescence!"

Today's method for estimating the future traffic attempts to recognize the traffic growth factors and thereby forestall early congestion and obsolescence.

Future traffic on modern freeway type facilities in either urban or rural areas has been subdivided as follows:
Current traffic: which would immediately use a highway improvement.

Attracted traffic: that which would be attracted from other, less desirable facilities to new one.

Generated traffic: that which develops soon after the new facility is opened and is attributable to better accessibility, convenience, and attractiveness.

Generated traffic, in contrast to attracted traffic, does not exist before the facility is opened. Example of it would be the seemingly spontaneous traffic increase that often comes when a bridge replaces ferry service or a poor road is replaced with a good one.

Normal traffic growth: which results from land development; but only from land development that would not have occurred without the new facility.

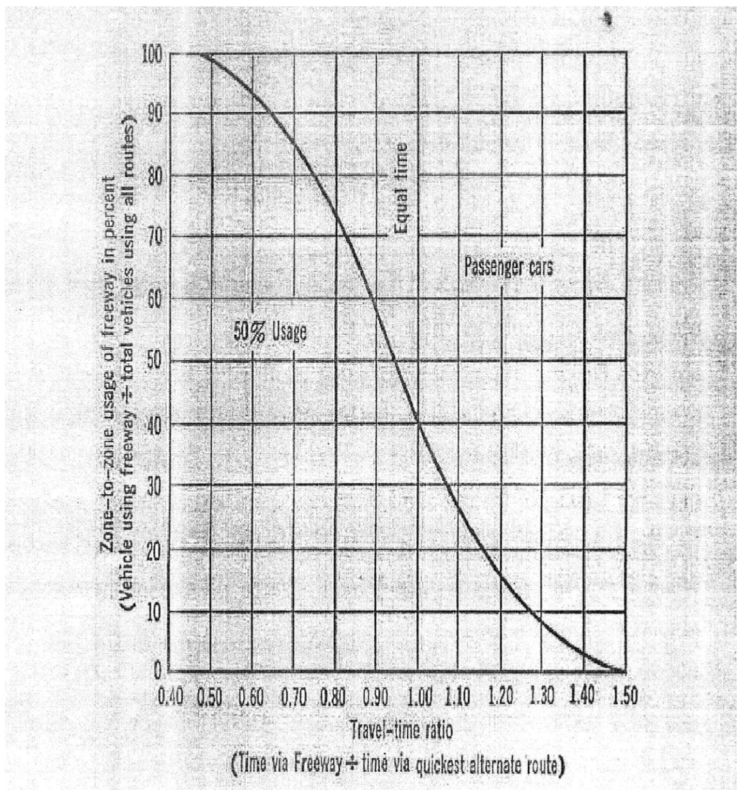


fig (e):- Time-ratio diversion curve. (Source: *Public Roads*, October 1959)

Method for estimating motorist's preference is given in Fig.e. Which suggest that diversions be allocated by means of a ‘travel time ratio’.

Several computer procedures for determining traffic volumes on free ways, with due recognition of diversion, have been developed. Traffic diversion charts indicates that many drivers place great importance in time saving; they are willing to drive extra distances and absorb the added costs of so doing to save time.

On arterial highways in urban areas, generated traffic varying between 5 and 30% of existing traffic occurs on most arterial improvements. Also it is expected that "normal traffic growth" will continue. The growth of developmental traffic is, of course, difficult to appraise, because it is dependent on, among other things, the economic development of the area and the nation.
Projected land uses probably offers the most reasonable clues.

It should be apparent that estimates of future traffic are difficult to make and approximate at best. Even so, the highway engineer must make them to the best of his abilities since predictions based on all available knowledge are far better than blind guesses.