Traffic Progression Models

(Platoon Movement, Robertson's Platoon Dispersion Model, Platoon Index & Applications)

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Overview

- Introduction
- Concept of Platoon Dispersion

  - Platoon Characteristics/Variables

  - Platoon Ratio
- Platoon Dispersion Models
  - Robertson's Model
  - Seddon's Formulation
- Conclusion

Introduction

- Problems in majority of metro cities:
- Congestion
- Delay-due to isolated functioning of traffic signals
- Necessary: Linking of Traffic Signals
- Traffic Progression Models model the vehicle movement characteristics

The concept of Platoon

- Definition of Platoon

  A bunch or group of vehicles travelling together

Platoon Characteristics/Variables

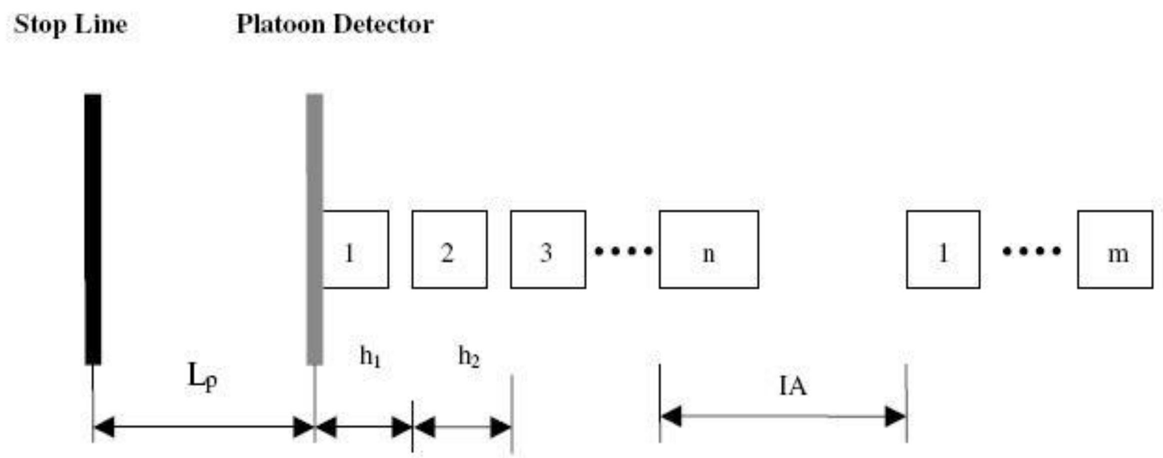


Illustration of Platoon Variables

- Platoon Size (N_p)
- Platoon Headway (h_p)
- Platoon Speed(V_p)
- Inter-Arrival (IA)

Platoon Characteristics/Variables

- Platoon headway (h_p) and Inter-Arrival(IA) are used for determination of Critical Headway

- Using Critical Headway, Platoon Size (N_p) and Platoon Speed(V_p) are determined for calculation of optimal signal timing

Platoon Ratio

- Numerical value defining the quality of traffic stream progression
- Used for calculating Delays, Capacity
- Identification of “Arrival Type” and Progression quality

Platoon Ratio

- Denoted as R_p

$$R_p = P\,(C/g)$$

Where,

P = Proportion of all vehicles during green time

C = Cycle length

g = Effective green time

– Range - 0.5 to 2.0

Platoon Ratio

EXHIBIT 15-4. RELATIONSHIP BETWEEN ARRIVAL TYPE AND PLATOON RATIO (R_p)

Arrival Type	Range of Platoon Ratio (R_p)	Default Value (R_p)	Progression Quality
1	≤ 0.50	0.333	Very poor
2	> 0.50–0.85	0.667	Unfavorable
3	> 0.85–1.15	1.000	Random arrivals
4	> 1.15–1.50	1.333	Favorable
5	> 1.50–2.00	1.667	Highly favorable
6	> 2.00	2.000	Exceptional

Platoon Dispersion

- Definition

As a platoon moves downstream from an upstream intersection, the vehicles disperse due to difference in vehicle speeds, vehicle interactions. This phenomenon is termed as “Platoon Dispersion”

Platoon Dispersion

- Function of

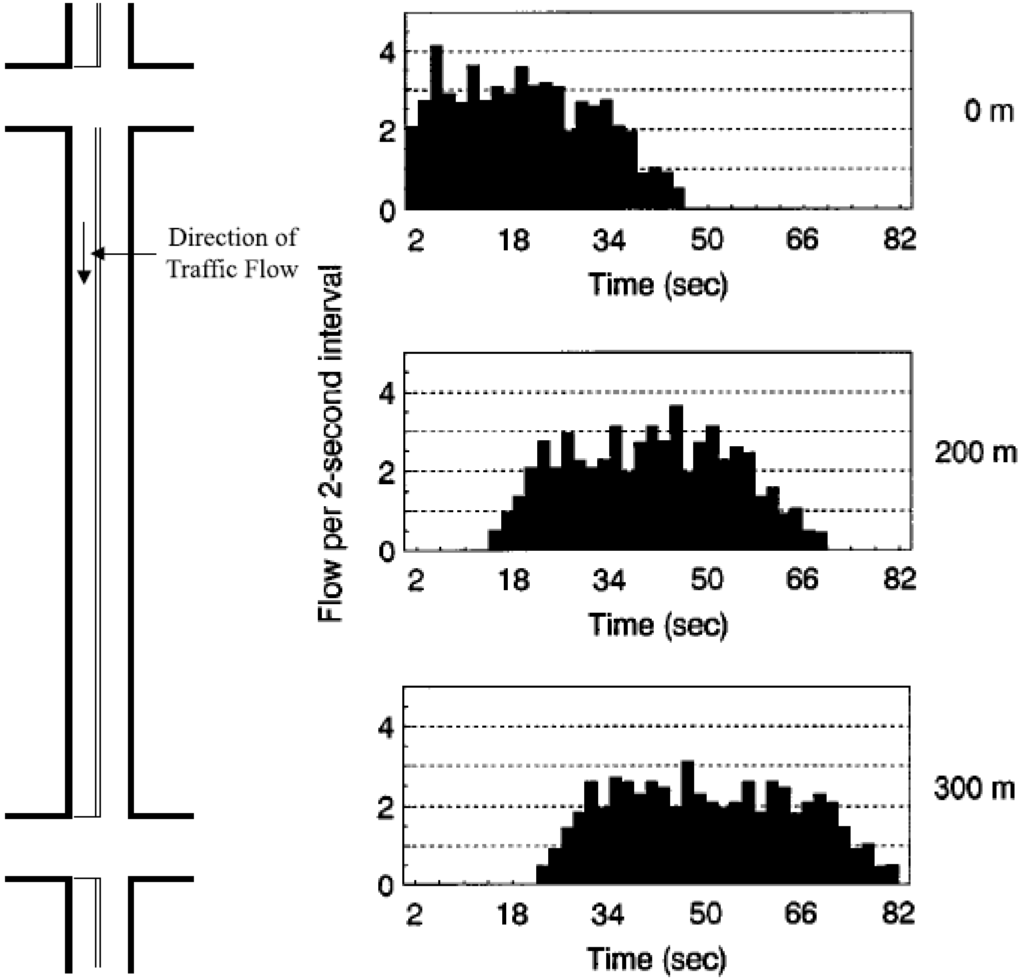
  - Travel time

  - Length of the Platoon

Longer the travel time, greater the dispersion.

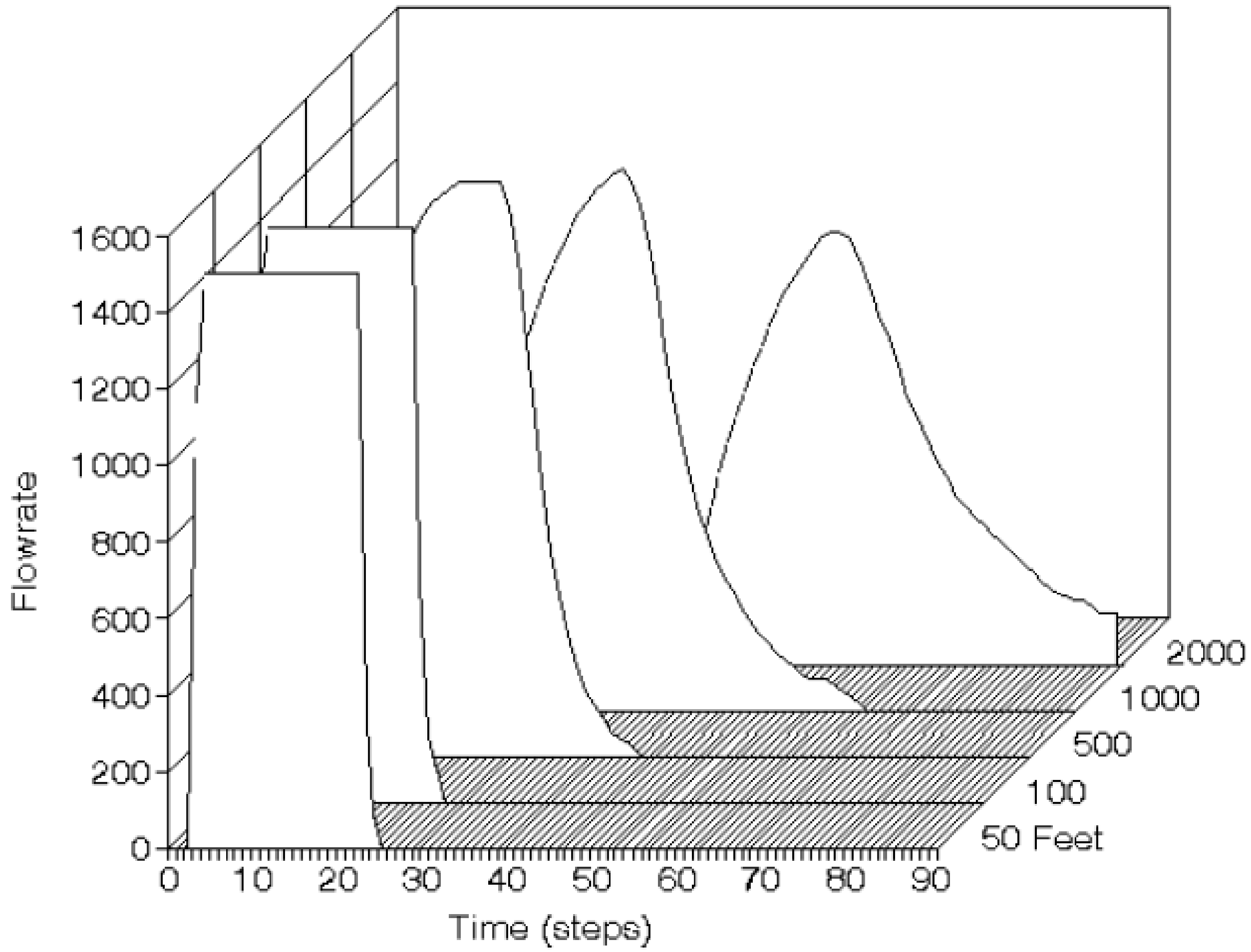
- TRANSYT and SCOOT predict the Arrival Type using the phenomenon of Platoon Dispersion

Platoon Dispersion



A simple case of Platoon Dispersion

Platoon Dispersion

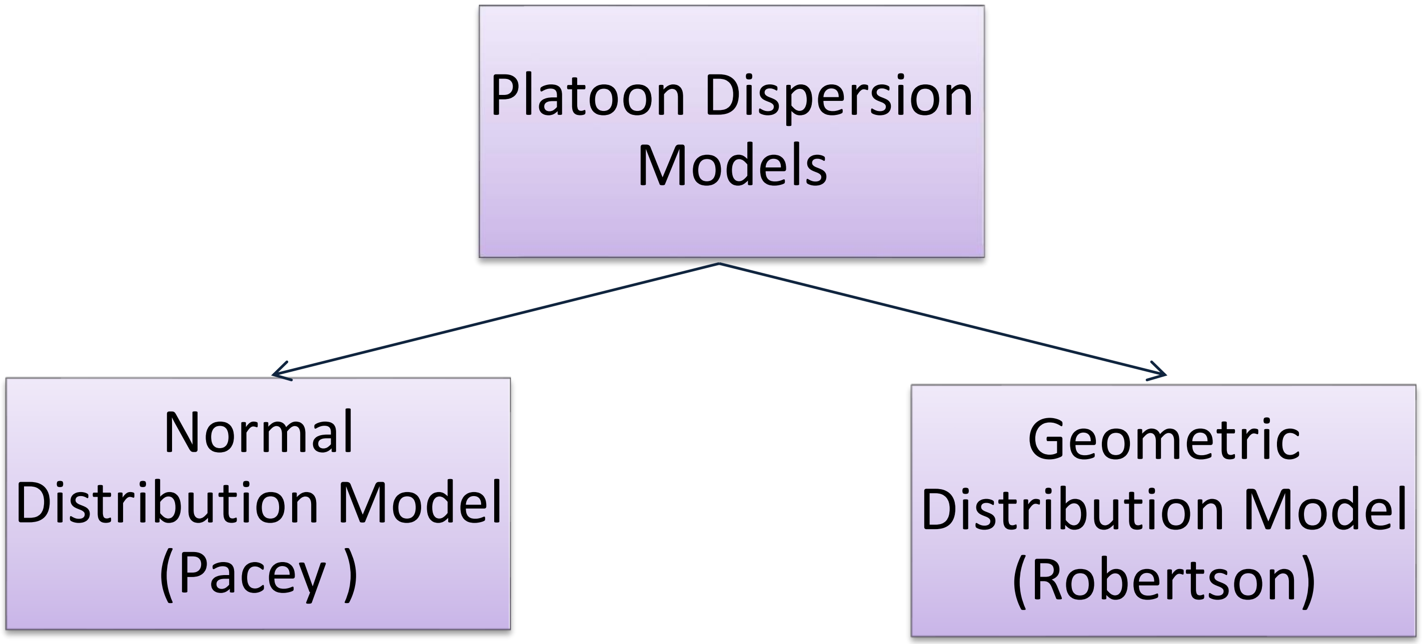


A simple case of Platoon Dispersion

Why Model Platoon Dispersion?

- Platoons originated at traffic signals disperse over time and space.
- Platoon dispersion creates non-uniform vehicle arrivals at the downstream signal.
- Effectiveness of signal timing and progression diminishes when platoons are fully dispersed (e.g., due to long signal spacing).

Platoon Dispersion Models



Platoon Dispersion Models

- Simulate dispersion of traffic stream by estimating vehicle arrivals at downstream based on an upstream vehicle departure profile and average traffic stream speed

- Most widely used – Robertson’s Platoon Dispersion Model

Robertson's Platoon Dispersion Model

Recursive mathematical form

$$\boldsymbol{q_t^d = q_{t-T}^u \times f + q_{t-\Delta t}^d \times (1 - f)}$$

q_t^d	=	downstream flow at time t
q_{t-T}^u	=	upstream flow at time $t - T$
$q_{t-\Delta\boldsymbol{t}}^d$	=	downstream flow at time $t - \Delta\boldsymbol{t}$
T	=	minimum travel time on the link
f	=	smoothening factor

Robertson's Platoon Dispersion Model

Recursive mathematical form

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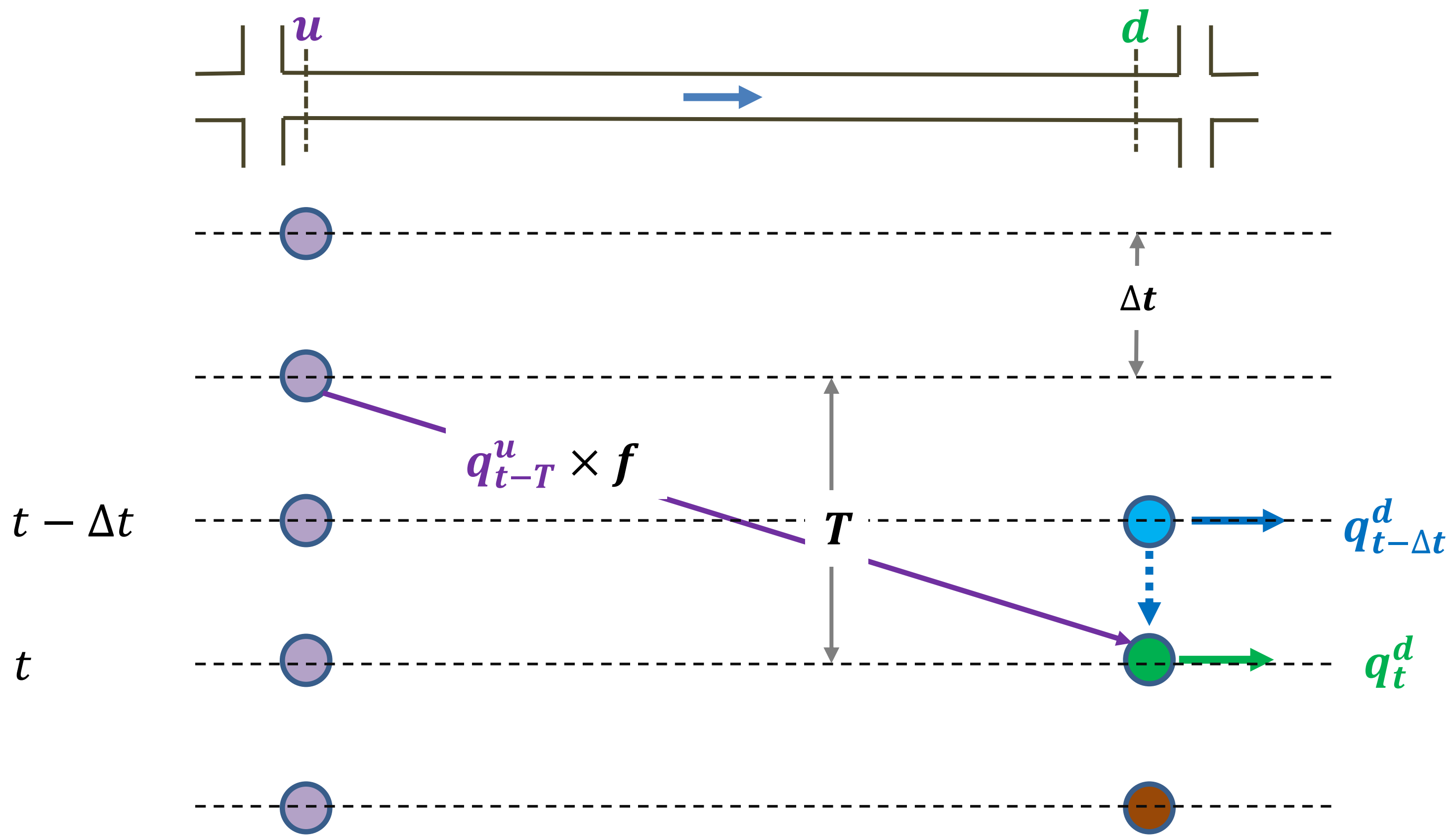

Robertson's Platoon Dispersion Model

Smoothening factor $\boldsymbol{f}$

$$f = \frac{1}{1 + \alpha\beta \frac{T_a}{\Delta t}}$$

α	=	unitless platoon dispersion factor
β	=	unitless travel time factor
T_a	=	average travel time
Δt	=	time update interval
T=βT_a	=	minimum travel time

Robertson's Platoon Dispersion Model

Problem:

In a case study, the average travel time for a particular stretch was found out to be 22.8 sec. and the platoon dispersion factor is 0.139, the travel time factor is 0.878 and the update interval is 10 sec. Find out the the flow at downstream at different time intervals where the upstream flows are as given below

$q_{10} = 20$, $q_{20} = 10$, $q_{30} = 15$, $q_{40} = 18$, $q_{50} = 14$, $q_{60} = 12$