In search of passenger saturation flow through transit doors

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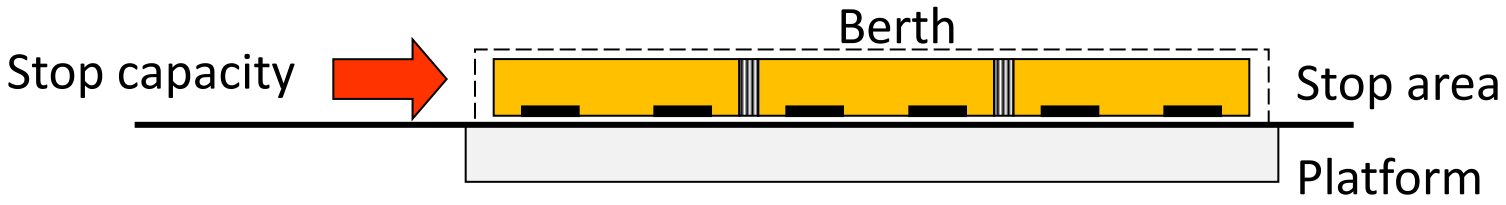
Outline

1. Transit stop capacity
2. Saturation flow concept
3. Human Dynamics Laboratory
4. Experiments
5. Results
6. Conclusions
7. Further research

Disclaimer

- For two high-confident reviewers
  - This is a borderline paper
  - Low/fair on scientific, practical, and innovation
- From authors
  - Pan-American Congress on Transport 2012, San Sebastian
  - European Transport Conference 2013, Frankfurt
  - Transportation Research A, August 2015, 78, 102-112
- This topic has nothing to do with transit networks
- <u>Do not expect too much on this presentation</u>

Transit stop capacity



$$C_s = \frac{3600\ N}{h_{s\,min}} \quad (veh/h)$$

(Vuchic, 2007)

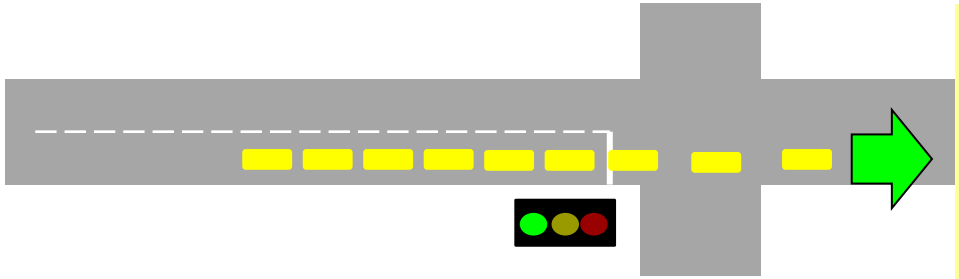
$$h_{s\,min} = t_{acc/dec} + t_{dwell} + t_{extra}$$

$$t_{dwell} = t_{oc} + t_a \cdot P_a + t_b \cdot P_b$$

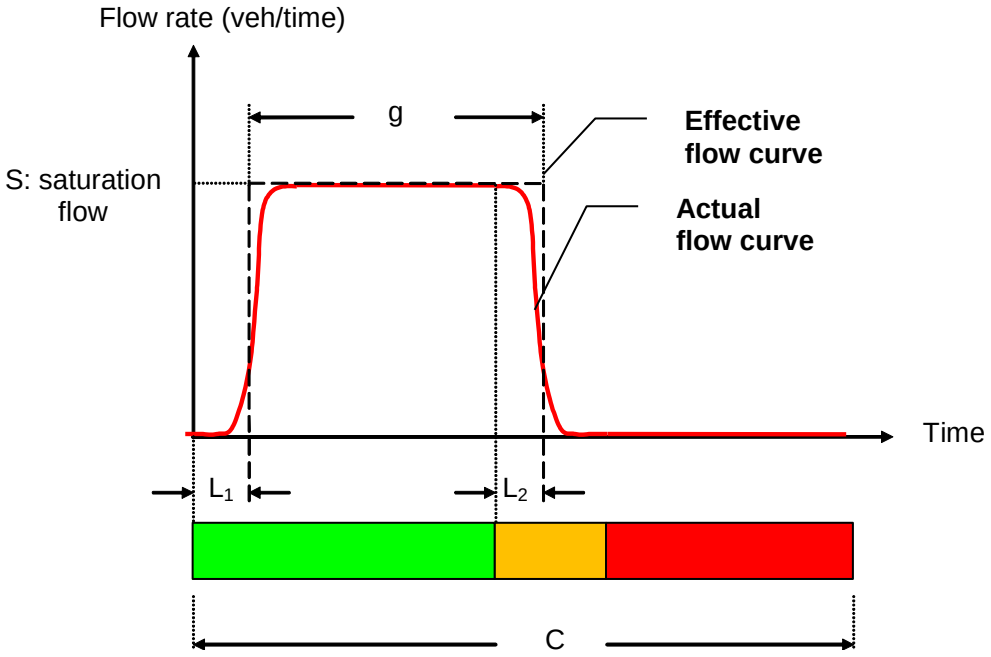
Transit Capacity Quality Service Manual (TRB,2013)

- «If a train's **dwell exceeds the average dwell** plus operating margin,… the following train will need to slow or stop to maintain the required safe separation distance and will not be able to approach the next station at its planned speed.»
- «This delay… will force the next train to slow or stop to maintain its required separation, **creating a cascade of delays to following trains that will be extremely difficult to resolve** as trains continue to arrive at the minimum headway.»
- «Transit agencies that operate **rail lines at or near the minimum headway [i.e. capacity] … try to manage station dwell times**… »

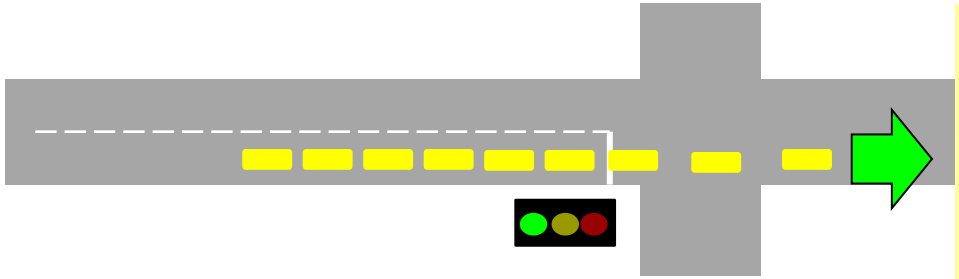
Saturation flow concept



Vehicle saturation flow
maximum steady state **unblocked discharge** vehicles from queue in green period



Saturation flow concept



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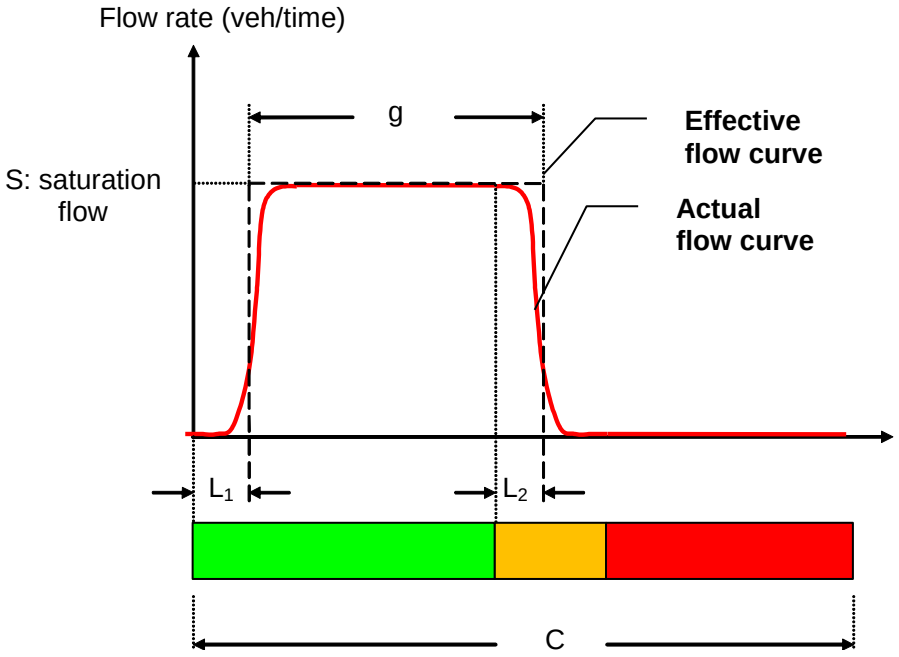

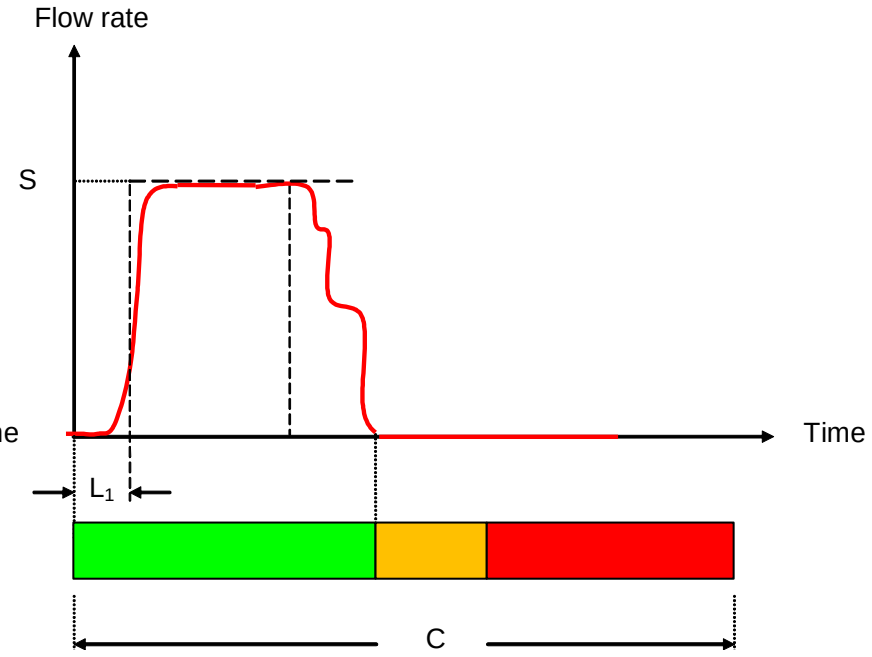

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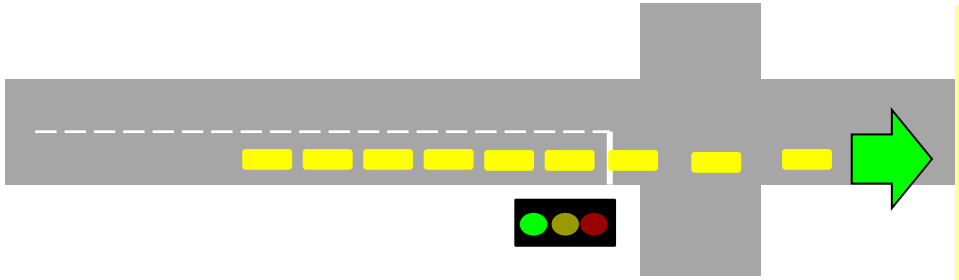
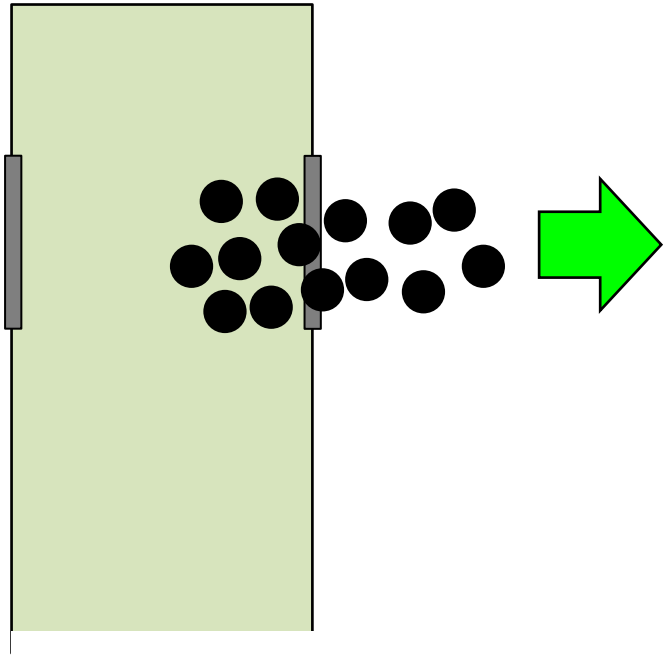
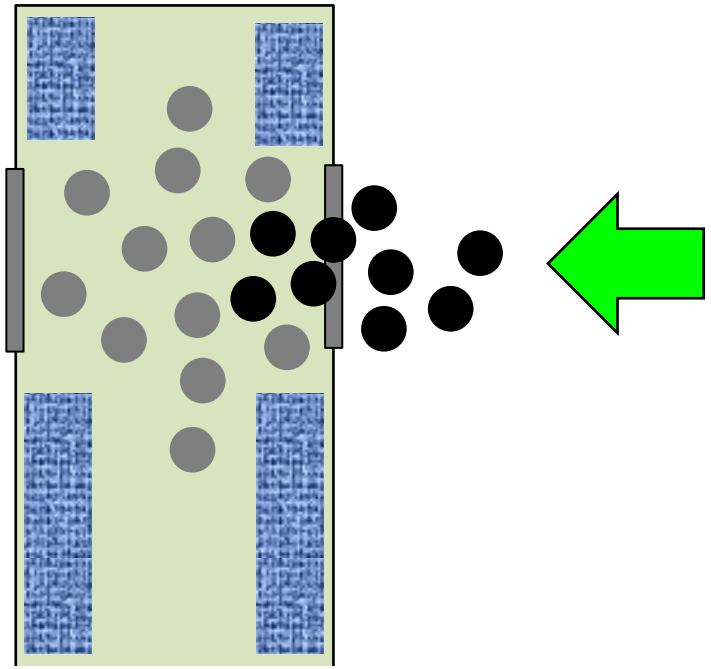


Vehicle saturation flow
maximum steady state **unblocked discharge** vehicles from queue in green period



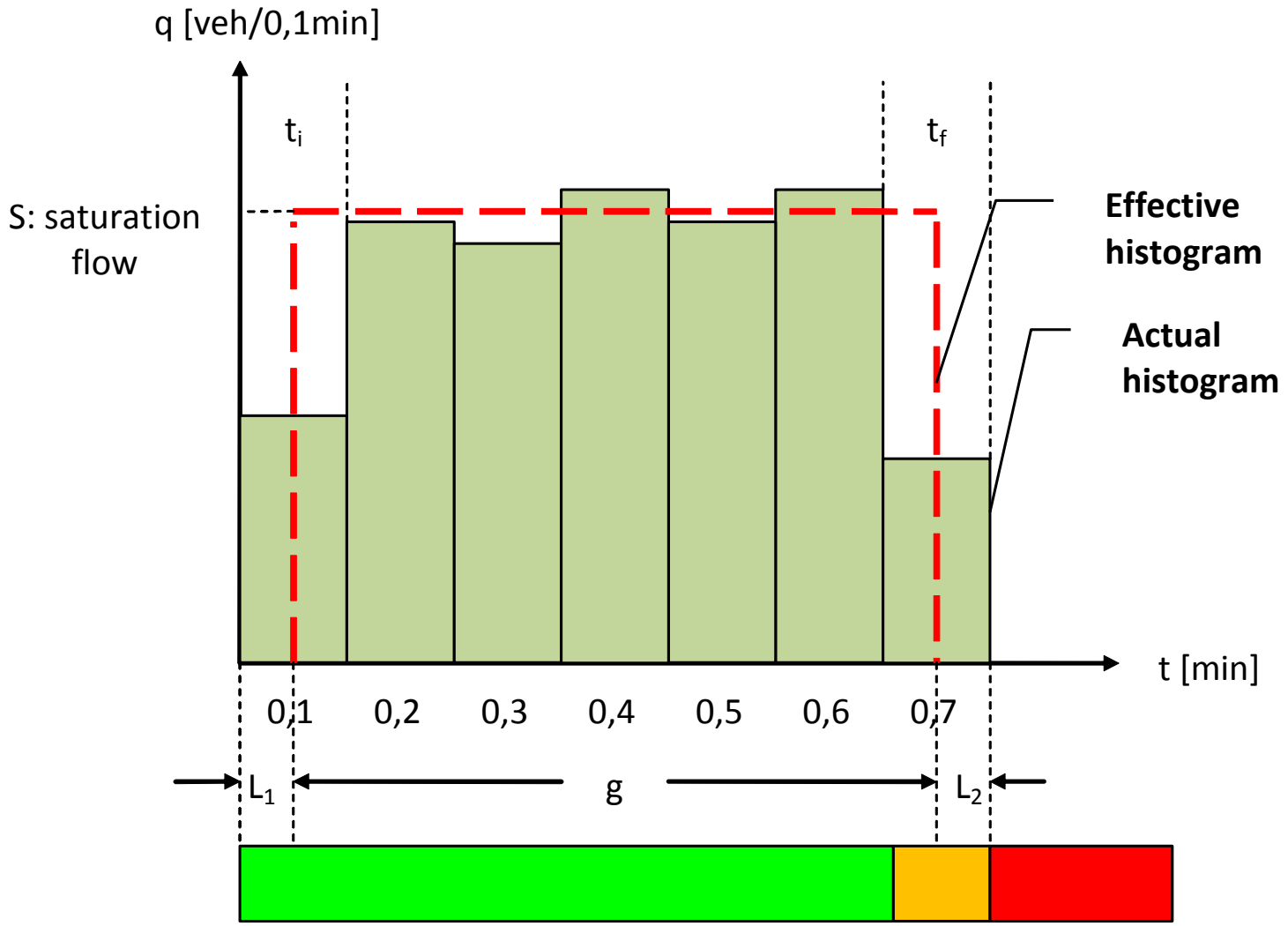
Passenger saturation flow?
maximum steady state **unblocked discharge** pass from group during door opening time

Why not boarding passengers?



<u>Blocked loading</u>
boarding rate depend on on-board density, internal layout, pass behaviour, …

Road Note 34 (TRL,1963)



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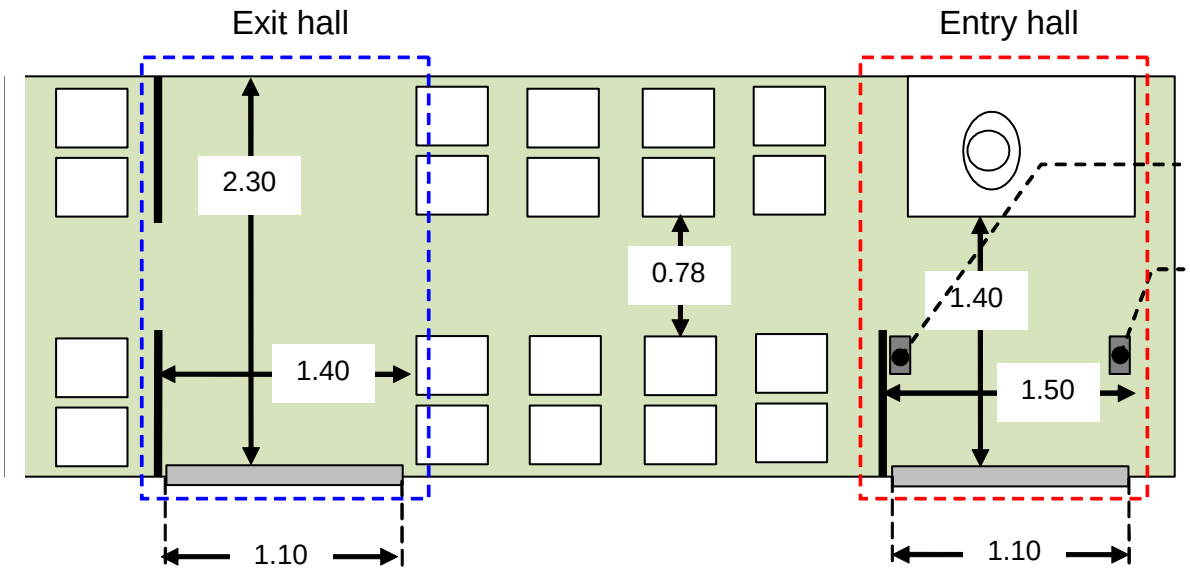
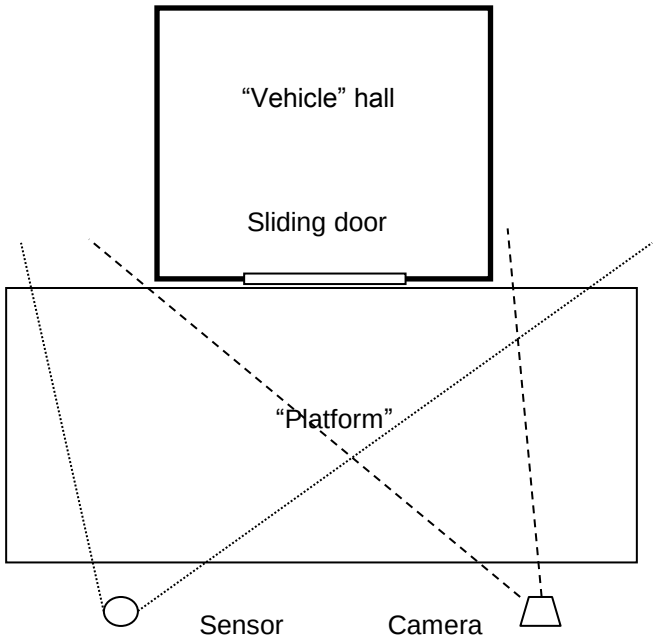
University of Los Andes – Chile



Mock-up of the hall



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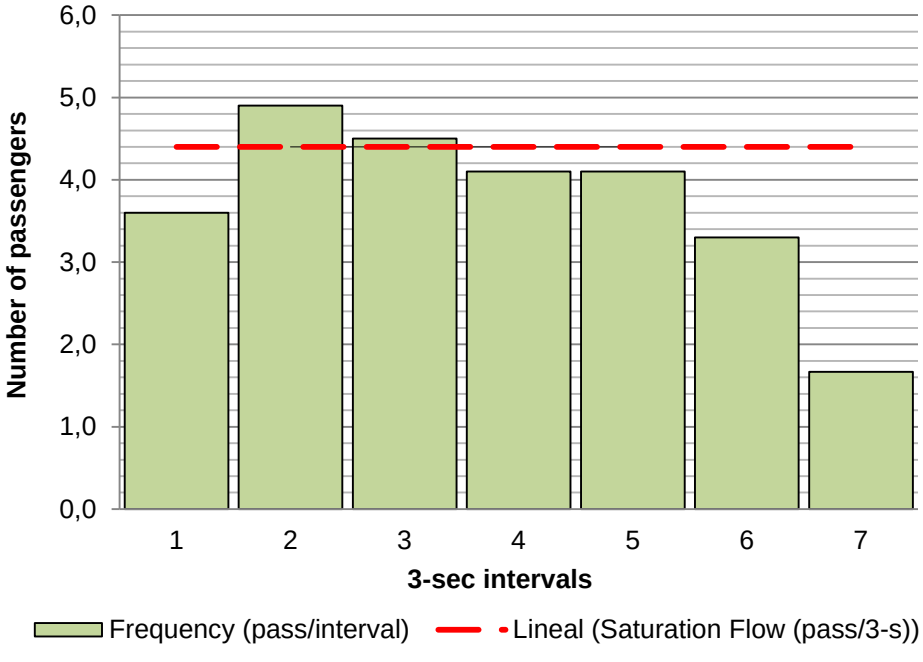
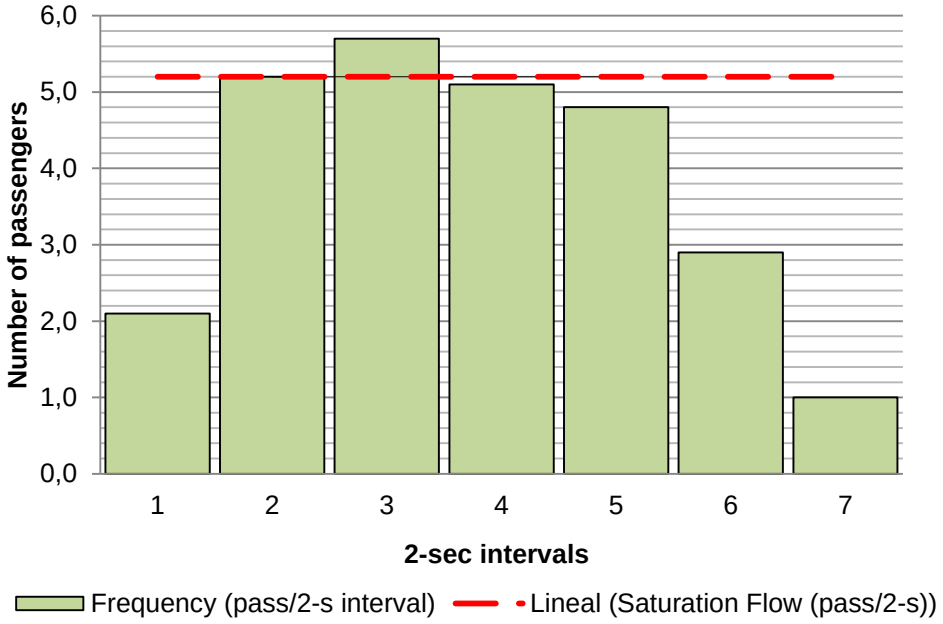
Experiments



800-mm door

1300-mm door

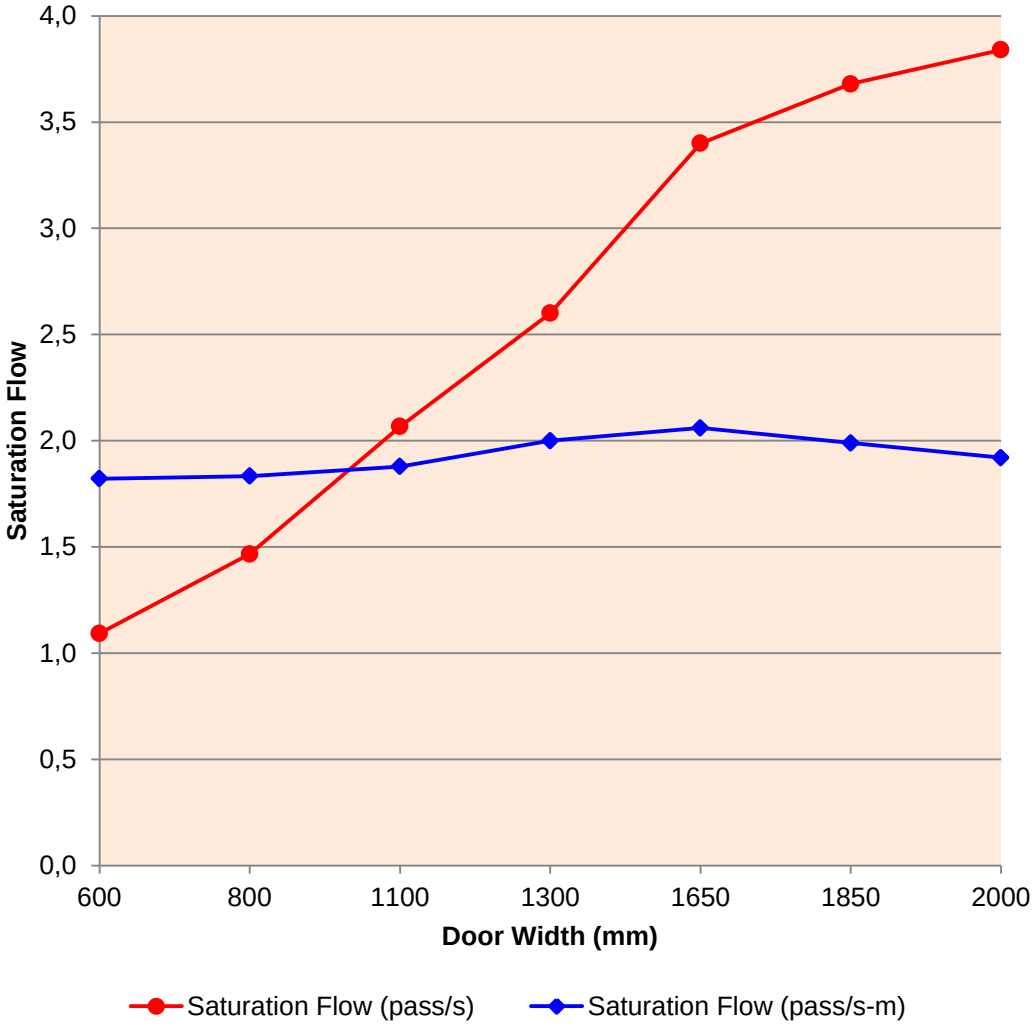


Results

Door width (mm)	Saturation flow		
	pass/s	pass/s-m	Type of vehicles
600			Does it exist?
800			**Minibus Transantiago**
1100			**Standard bus Transantiago**
1300			**Old rolling stock Metro Santiago**
1650			**New rolling stock Metro Santiago**
1850			**LU Jubilee Line**
2000			Does it exist?

Results

Door width (mm)	Saturation flow	
	pass/s	pass/s-m
600	1.093	1.822
800	**1.467**	**1.833**
1100	**2.067**	**1.879**
1300	**2.600**	**2.000**
1650	**3.400**	**2.061**
1850	**3.680**	**1.989**
2000	3.840	1.920



Conclusions

- On saturation flow
  - Signals for vehicles $\Leftrightarrow$ doors for passengers
- On capacity transit doors
  - Passenger saturation flow $\approx$ 1.8 – 2.0 pass/s-m
  - Grater than $1/t_a$ in dwell time equation
- Suitability RN 34 for people (pass, peds)
- Advantage real-scale laboratory experiments

Further research

- Vertical & horizontal gap
- Location of handrails & seats
- On-board passenger density
- Passenger traffic management platforms
- Other applications
  - Vehicle evacuation times
  - Pedestrian crossings
  - Turnstiles

Acknowledgements

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