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A study of the opening size of auxiliary lanes on the driving behavior- based analysis

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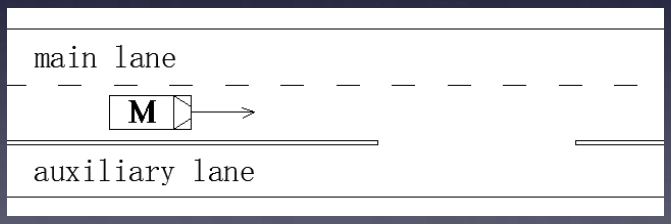
Introduction

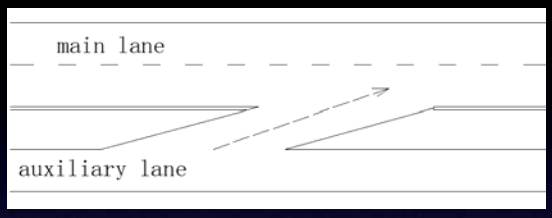
What is auxiliary lane?

lower-grade highway (lower speed)
for the vehicles to enter and exit the high-grade roads
for the vehicles not permitted into the high-grade roads
an important means of access management control

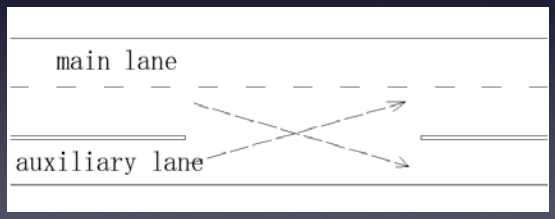


This is auxiliary lane

Forms of auxiliary lane



Integral auxiliary lane



Segregated auxiliary lane

Function of auxiliary lane

Speed transition :

to transversely isolate the fast traffic flow from the slow traffic flow in space

The opening area

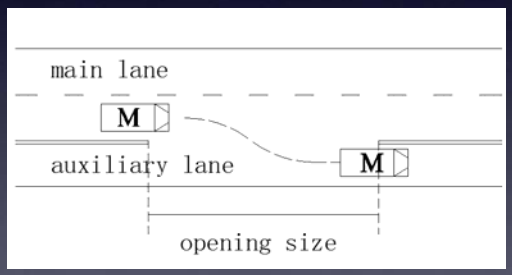
Where vehicles enter and exit the main lane

Where vehicles' speed changes

Where traffic danger conceals

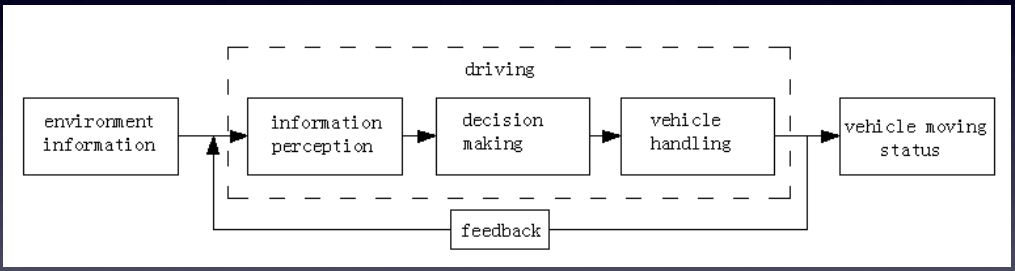
Problem we face

What is the best length ?

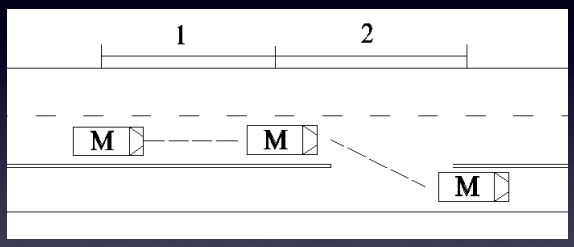


Analysis on Driving Behavior

Phases of driving behavior



Stages of lane changing



1.Decelerating stage

2.Turning stage

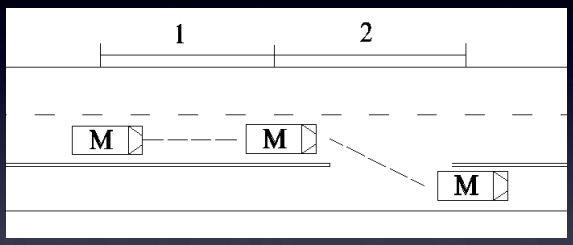
Stages of lane changing

1.Decelerating stage

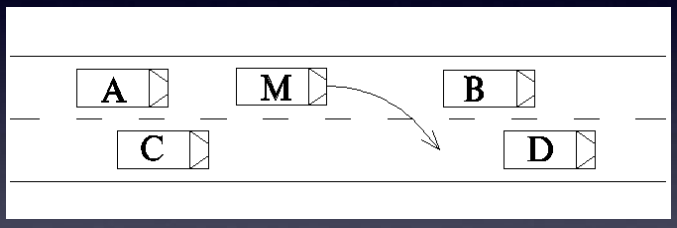
2.Turning stage

Notice the opening location
Stomp the brake pedal
Adjust the vehicle speed

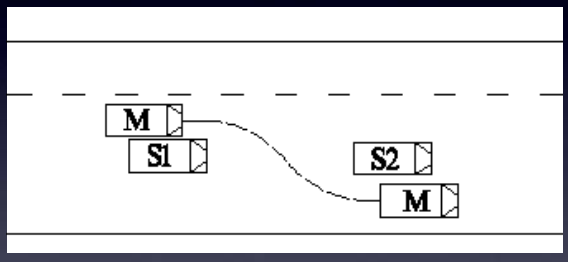
Notice the opening size (angle)
Turn the steering wheel
Change the lane



Lane changing behavior



Terms of Assumption



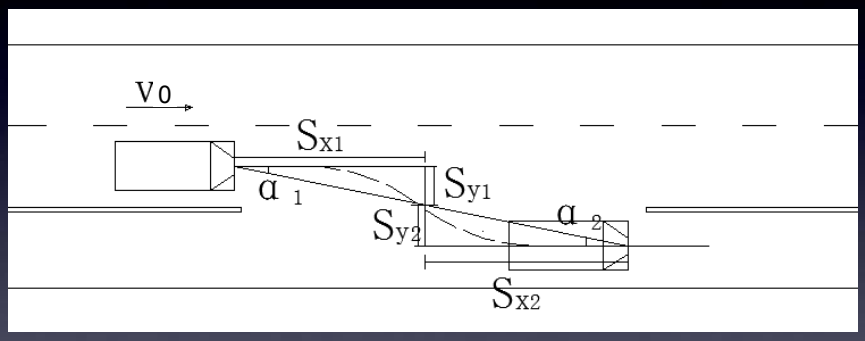
Model specification

Terms of Assumption

1) The lateral motion does not affect the longitudinal motion

2) The process of lane changing has geometric center symmetry

Description of model



Jose L Bascunana(1995)

The Vertical Deviation Angles α_1 &α_2 are quiet small

In longitudinal motion

longitudinal velocity $V_{x1}=V_{x2}=V_0$

(1) $S_{x1}=V_{x1}t_1$, $S_{x2}=V_{x2}t_2$

In lateral motion

Vehicle speeds up at first and then slow down

Lateral velocity changes from 0 to Max, then to 0 again

The acceleration process is short to be two uniformly accelerated motions

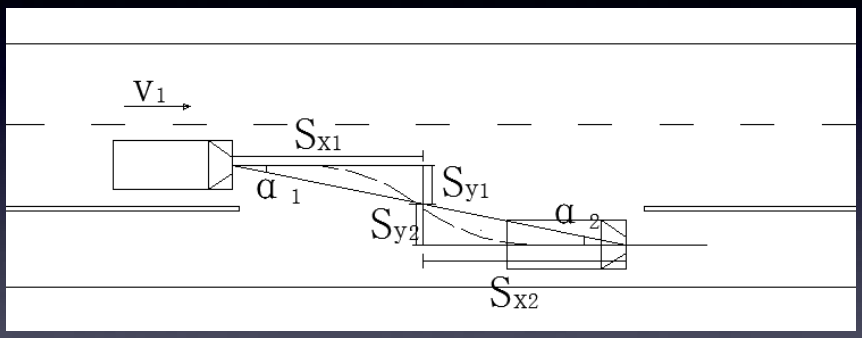
(2) $S_{y1}=0.5\ a_1\ t_1^2$, $S_{y2}=0.5\ a_2\ t_2^2$

Constraints of lateral movement

(3) $S_{y1} + S_{y2} \geq W_l$

where W_l stands for one lane's width

Center symmetry



(4) $a_1 = a_2 = a$

(5) $t_1 = t_2 = t$

Constraints of longitudinal movement

(6) $S_{x1} + S_{x2} \leq OS$

where OS stands for opening size

We can get

$$(7)\ OS \geq 2\ V_0 \sqrt{W_l/a}$$

Minimum Opening Safe Spacing

Definition

$$MOSS = 2V_0\sqrt{W_l/a}$$

where MOSS stands for
Minimum Opening Safe Space

Guideline to design

The design velocity of auxiliary lane is 30~40 km/h
So V_0 ranges 20~50 km/h for $|\Delta V| \leq 20$km/h

According to *Specification for Design of Urban Expressway*
Code for design of urban road engineering
Design Specification for Highway Alignment

The width of lane W_l = 3.75m
The acceleration a = 0.1g for stability and comfortableness

The value table of MOSS

Velocity (km/h)	20	30	40	50
Calculated Value (m)	21.7	32.60	43.47	54.34
Recommended Value (m)	25	35	45	55

Simulation Test &Results

Preparation

Programming :UC win / road

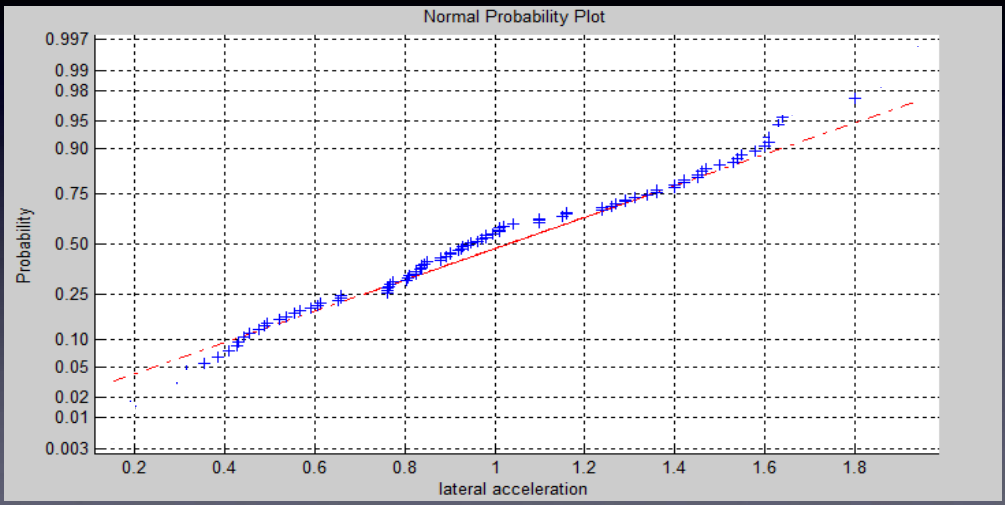
Scene : 1 km 2-lane highway with auxiliary lane ,which opens at 700m

Volunteer : 30 with ten-year driving experience
20 unskilled

Parameter :v=40 km/h os= 45m

Test: mean lateral acceleration

Data



Results

1.Normality of the test data demonstrate that the model conforms to driver's driving habits.

2.Lower acceleration , easier to control the vehicle, as the unskilled does.

3.More people would like to drive in a high speed, then hasty handling happens when they change lane from the main to the auxiliary.

Further study

1.Whether vehicles' size affects the design of the auxiliary lane opening

2.Whether different lighting conditions affects the variation of vehicle moving status in the opening area

Thank you