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The Impact of Community Opening on Road Access

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Abstract: This paper mainly studies the impact of the opening of the district on the surrounding road traffic. According to the road impedance function model and the Braess paradox, combined with the analogy method, the control variable method and the function image method, the matlab software is used to analyze the influence of different types of community opening on the surrounding roads. We use road impedance as the ultimate indicator of the impact of community opening on the surrounding roads. We use the road impedance as indicators of impact assessment areas open to the surrounding roads. When the road impedance is large, the patency of the road network is poor. On the contrary, when the road impedance is small, the patency of the road network is good. Finally, we analyze the advantages and disadvantages of the model, and put forward the improvement plan, and then put forward some suggestions for the opening of the district, show the opening of the district on the impact of road access.

1. Background analysis

February 21, 2016, the State Council issued "on the further strengthening of urban planning and construction management of a number of opinions". One of the sixteenth, on the promotion of street system, in principle, no longer building a closed residential area, has been completed residential quarters and units to be gradually open. These views have attracted wide attention and discussion.

In addition to the security issues that may be triggered by the opening of the community, one of the focuses of the discussion is whether the open community can achieve the objective of optimizing the road network structure, improving road capacity, improving the traffic conditions. And what kind of improvement will be achieved. One view that closed-cell destruction of the urban road network structure, blocking the city "capillaries", likely to cause traffic congestion. After the opening of the district, the road network density increases, the road area increases, the traffic capacity will naturally improve. Some people think that this is connect to district area, location, external and internal road conditions and many other factors. So this view can not be generalized. Some people think that after the opening of the district, although the road can be increased, accordingly, the district on the main road into and out of the intersection of the intersection of vehicles will increase, may also affect the main road traffic speed.

2. Model hypothesis

(1) Assuming that all road designs are in line with the Urban Road Design Code.

(2) Assuming that the road junctions around the area are controlled by traffic lights, there is no road junction without control signals.

(3) In the analysis of road impedance and road capacity, it is assumed that no traffic special circumstances such as car accident and construction will affect the road traffic.

(4) It is assumed that the presence of pedestrian and non-motorized vehicles has no effect on road capacity.

3. Symbol Description

symbol	Description
e	The time required to pass the unit section
v	The speed at which the vehicle is free to travel on the road
q	Traffic flow on the unit section
l	The length of the section
$t_\alpha(0)$	The average free travel time of vehicles on section a
e_α	The traffic capacity of road section a
v_α	Road design speed
y_{ij}	Vehicle delay (time impedance)
T_c	Signal period time
x	saturation
d_{ij}	Section impedance
Q	Starting point traffic volume
α_n	Traffic on the road ij on the average free travel time
α_x	Free travel time for adjacent or intersecting roads with ij
β_n	The delay parameter on the ij section

4. The Establishment and Solution of Model

The travel time on the section constitutes a complex function of distance and flow. For the unit length of the road (the same nature of the road) can constitute the time - traffic flow relationship function.

$$t = \frac{1}{v} f(q) \tag{1}$$

For the road impedance function model, many experts use a variety of methods of research. The main methods are to carry out theoretical modeling and regression by observing data, some of which have been used now. The most representative of the current road impedance model is Bureau BPR impedance function model of the US Highway.

$$t_\alpha = t_\alpha(0)\left[1+\alpha\left(\frac{q_\alpha}{e_\alpha}\right)^\beta\right] \tag{2}$$

In this formula, α, β −−Regression parameters , typical values of α is 0.15, typical values of β is 4.

Synthesis (1) and (2), we get the traffic impedance function on the section as follows.

$$t_\alpha = \frac{l}{v_\alpha}\left[1+\alpha\left(\frac{q_\alpha}{e_\alpha}\right)^\beta\right] \tag{3}$$

The US Road Authority's BPR formula is based on observational data from the interstate road, which is appropriate for road traffic impedance. However, the city's road network, intersection is more intensive, the vehicle spent about 20% to 40% of the travel time at the intersection. This is obviously not negligible.

There are many ways to calibrate the signal intersection impedance, the more famous of which is the Webster formula:

$$y_{ij} = \frac{T_c(1-\lambda)^2}{2(1-\lambda x)} + \frac{x^2}{2q(1-x)} - 0.65\left(\frac{T_c}{q^2}\right)^{\frac{1}{3}} x^{(2+5x)} \tag{4}$$

We define the total road impedance in the road network as:

$$t_{ij} = \sum d_{ij} + \sum y_{ij} \tag{5}$$

When crossing the intersection, it is assumed that the total value of the traffic flow is constant and distributed proportionally according to the size of the traffic capacity on each road.

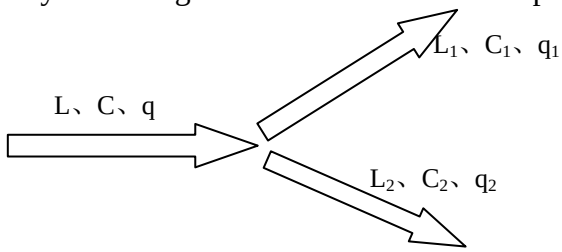

Fig. 1 Traffic flow distribution model

In Fig.1, $q_1 = \frac{C_1}{C_1 + C_2} q, q_2 = \frac{C_2}{C_1 + C_2} q$. C represents the capacity of road L.

Through the above formula, we get the following four pictures:

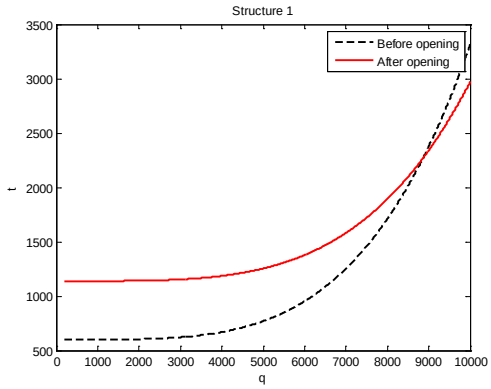

Fig. 1 Structure 1

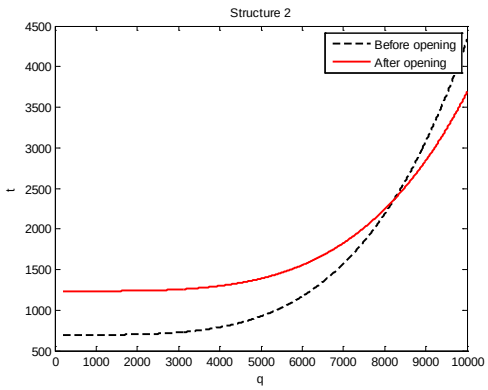

Fig. 2 Structure 1

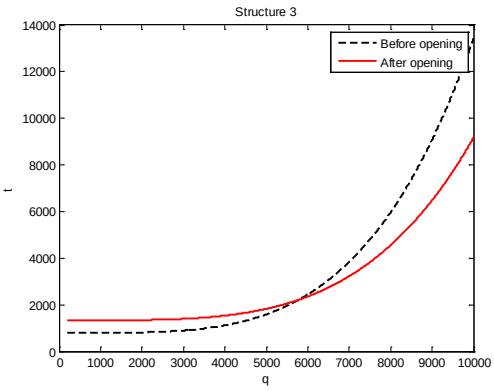

Fig. 3 Structure 1

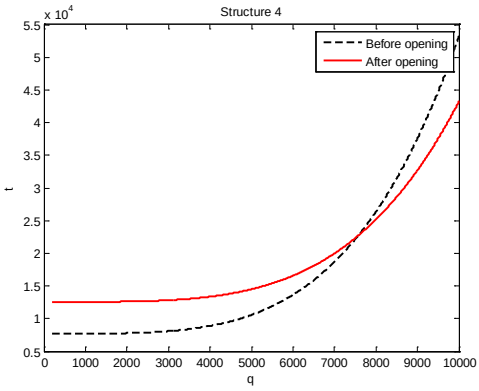

Fig. 4 Structure 1

5. Model conclusion

After the total traffic flow reaches or exceeds the critical intersection (the road impedance after the opening of the cell is smaller than the road impedance before the opening of the cell), the opening of the district will have a good influence on the surrounding traffic.

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