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## Discuss on influence of college mathematical modeling on the construction and improvement of traffic flow model

Guirong Yuan

Quality Teaching Department of Chongqing Electric Power College, Chongqing, 400053, (CHINA)

### ABSTRACT

With the construction and development of urban traffic network, traffic flow has been the core of urban traffic management, while constructing scientific and reasonable traffic flow model plays an important role in traffic system. During the process of construction, college mathematical modeling system is employed and at the same time, the influence of main factors on traffic flow is analyzed as well as negative effect of objective factors such as natural environment on traffic flow also should be paid attention to. The construction of traffic flow is a kind of dynamic process, which takes advantage of the feature of mathematical modeling to traffic flow to design parameters and then to construct traffic flow equation which is consistent with reality. During the course of studying, the research on relative variables of affecting traffic per minute on highway is needed to conduct. Based on the theory of calculus, the construction of college mathematic modeling to traffic flow model takes vehicles on road as continuous particles to build traffic flow model. In the process of constructing traffic flow model by using college mathematical modeling, the thesis analyzes relevant parameters in the model by making use of direct and indirect traffic flow equation. On this basis, the thesis conducts the further construction and improvement of traffic flow in mathematical modeling system. During the process of study and analysis, the paper puts forward the matters that need to pay attention to in the process of building model, the set of traffic flow parameters, analysis of effect factors and the set of traffic flow equation to finally decide the structure of traffic flow and then to effectively manage and control urban traffic.

### KEYWORDS

College mathematical modeling; Traffic flow model; Variable; Improvement.



## INTRODUCTION

In recent years, as the increase in the number of motors on the road, the problem of traffic vehicle flow is more serious and hence, it is necessary to construct a reasonable and feasible motor motion model. Currently, with the continuous economic development and progress of society, the number of vehicles on the road is increasing. In recent years, the constant increasing of vehicles on the highway needs to set up a feasible motor motion theory and in the meantime, for the rising incidence of traffic accidents, the thesis analyzes the dominant factors influencing the traffic flow and causing traffic accidents and construct reasonable and effective structure of traffic flow model. The construction of traffic flow model under traditional model has a certain disadvantages, which does not comprehensively reflect the impact factors in model structure and the construction of the equation and then leads to the fuzziness of the model structure system. In order to further break through the building of traffic flow model in traditional mode, the paper constructs the traffic by mainly using college mathematical modeling system. Through the construction of traffic flow model by making use of college mathematical modeling system, the thesis analyzes and studies the variables and factors that affect traffic per minute. During the modeling, it is assumed that the vehicles on the road are moving along the single lane, among which, the whole motorcade is not overtaken and no vehicles enter or leave from the motorcade. The model is constructed based on the situation to create one-dimensional motion equation by constructing traffic flow model through using college mathematic modeling system.

### VARIABLES OF AFFECTING TRAFFIC MODEL CONSTRUCTION IN COLLEGE MATHEMATIC MODELING

In construction of traffic flow model by using college mathematical modeling, it is needed to analyze and study related variables and factors that affect traffic on the road per minute. Through construction of traffic flow model by using college mathematic model to analyze and study the variables and factors that affect traffic on the road per second, the main factors contain three variables: the flow, velocity and density of traffic flow and the influence of the relationship among the three variables on traffic<sup>[1]</sup>. Among them, the main variables of traffic flow include three variables: the flow, velocity and density of traffic flow as well as the correlation among the three main variables<sup>[2]</sup>. The main variables are constructed as follows:

The flow of t time in traffic flow  $q(x, t)$ , the number of vehicles crossing point x on road in a unit time;

The velocity in traffic flow  $u(x, t)$  the velocity of crossing point x at t time;

The density in traffic flow  $\rho(x, t)$  the number of vehicles on point x on road.

Apart from the above three variables which are main factors affecting traffic, there are another factors which have an influence on construction of traffic flow model, as TABLE 1 shows:

**TABLE 1 : Analysis of objective factors affecting traffic flow**

Serial Number	Factors	Type	Function
1	Lane Width		Positive Impact
2	Number of Lanes		Positive Impact
3	Lateral Clearance		Positive Impact
4	Interchange Density	Geographic Factor Impact	Negative
5	Horizontal Curve Radius		Positive Impact
6	Longitudinal Slope		Negative Impact
	Rain and Snow	Weather Factor Impact	Negative
8	Visibility		Positive Impact

### THE CONSTRUCTION OF TRAFFIC FLOW MODEL EQUATION

#### The construction of continuous traffic flow model equation in college mathematical modeling

During the construction of traffic flow model by using college mathematical modeling, it is needed to analyze and study the traffic conditions of an interval on the road. At present time, the number of vehicles on highway is continuously increasing with the level of economic society. Due to the seriousness of the problem of traffic flow, it is necessary to build reasonable and feasible motor motion model. The construction of traffic flow model by using college mathematical modeling needs to analyze and study variables and factors which affect traffic per second on road, i.e. three variables of the flow, velocity and density of traffic flow and the influence of the relationship among the three variables on traffic.

With the economic progress in recent years, the number of vehicles on road presents a trend of growth. In present highway, different type of vehicles runs on road constantly<sup>[3]</sup>. For the continue growth of traffic flow on highway in recent years, it is particularly critical to set up a reasonable motor motion rule. In the interval, it is assumed that there are no other

vehicles joining in the motorcade driving on highway and also no situations that vehicles disappear. It is analyzed according to the conservation law of traffic vehicles, in a certain period or intervals, the number of vehicles crossing the road should meet the following equation, i.e.:

Increment of vehicles' number = Inflow - Outflow

In accordance with analyzing the above variable of traffic flow, the traffic flow equation among the flow  $q(x, t)$ , velocity  $u(x, t)$  and density  $\rho(x, t)$  of traffic flow in college mathematical modeling system is finally built. In the process of constructing model, when the density  $\rho(x, t)$  of traffic flow is disconnected, this is more common situation of traffic flow in college mathematical modeling system. During the process, there will be several continuous points which are expressed with  $(x, t)$  in the constructing process of traffic flow model. Furthermore, due to the continuous phenomenon, the continuous point  $(x, t)$  will form a straight line in traffic plane which is expressed with  $x = x_s(t)$  in the construction of traffic flow. Next, it is the analysis of continuous traffic flow equation that  $x_s(t)$  meets by using college mathematical modeling.

In the process of constructing traffic flow model by using college mathematical modeling, the changes of vehicle's number on highway in a certain period should be effectively analyzed, among which, period is expressed with  $(t, t + \Delta t)$ , the section of vehicles running on highway is expressed with  $(x, x + \Delta x)$  and the approximation of vehicle's number from a point  $x$  to the running section is expressed with  $q(x + \Delta x, t)\Delta t$ . Making use of college mathematical modeling to calculate the approximation of vehicle's number in the period of  $(t, t + \Delta t)$  in above section of highway, the final result is

$$(q(x, t) - q(x + \Delta x, t))\Delta t$$

Moreover, if the density of traffic flow  $\rho(x, t)$  in period  $\Delta t$  is changed into  $\rho(x, t + \Delta t)$ , by using college mathematical modeling, the final calculation of approximation of vehicle's number in the section is  $(p(x, t + \Delta t) - p(x, t))\Delta x$ .

According to basic conservation law in traffic to calculate traffic flow variables equation in this section and the final result is as follow, i.e.:

$$(q(x, t) - q(x + \Delta x, t))\Delta t = (p(x, t + \Delta t) - p(x, t))\Delta x \tag{1}$$

Then, in accordance with the calculus theory in higher mathematics, both sides of the above equation (1) are divided by  $\Delta t$  and  $\Delta x$  to finally construct the following equation, among which, the values of two variables are close to zero, i.e.:

$$\frac{\partial q}{\partial x} + \frac{\partial p}{\partial t} = 0 \tag{2}$$

The above two equations are traffic flow equation constructed by using college mathematical modeling system. Among which, the equation is mainly composed of two unknown qualities  $p$  and  $q$  and to finally establish reasonable mathematical modeling. On the basis, plug the known function  $q(\rho)$  into the second equation and the final equation is as follow, i.e.:

$$\frac{\partial q}{\partial x} = \frac{\partial q}{\partial p} \frac{\partial p}{\partial x} = F'(p) \frac{\partial p}{\partial x} = \varphi(p) \frac{\partial p}{\partial x} \tag{3}$$

In the equation, the known function  $dq / dp = \varphi(p)$  is established through mathematical modeling. According to the above analysis, the second equation also can be written as

$$\frac{\partial p}{\partial t} + \varphi(p) \frac{\partial p}{\partial x} = 0, -\infty < x < \infty, t > 0 \tag{4}$$

During the process of analysis, the length of the section should be taken into consideration and in the process of constructing whole equation, if the length is shorter, the inflow will equal to outflow. When vehicles cross  $x_s(t) + \varepsilon$ , in  $(t, t + \Delta t)$ , the number of vehicles that vehicles outflow from the section can be calculated by using traffic flow minus the flow in  $x_s(t + \Delta t) + \varepsilon$ . Through the above calculation, the final result of vehicle's number in specific section is as follows, i.e.:

$$q(x_s(t) + \varepsilon, t)\Delta t - p(x_s(t) + \varepsilon, t)(x_s(t + \Delta t) - x_s(t)) \tag{5}$$

In the third equation,  $f(x)$  refers to initial density in traffic flow and the final result  $\rho(x, t)$  is used for describing the distribution of vehicle flow in any period in highway section to obtain traffic flow function  $q(\rho)$ . As Figure 1 shows, it is the flow chart of determining influencing parameters of traffic flow model.

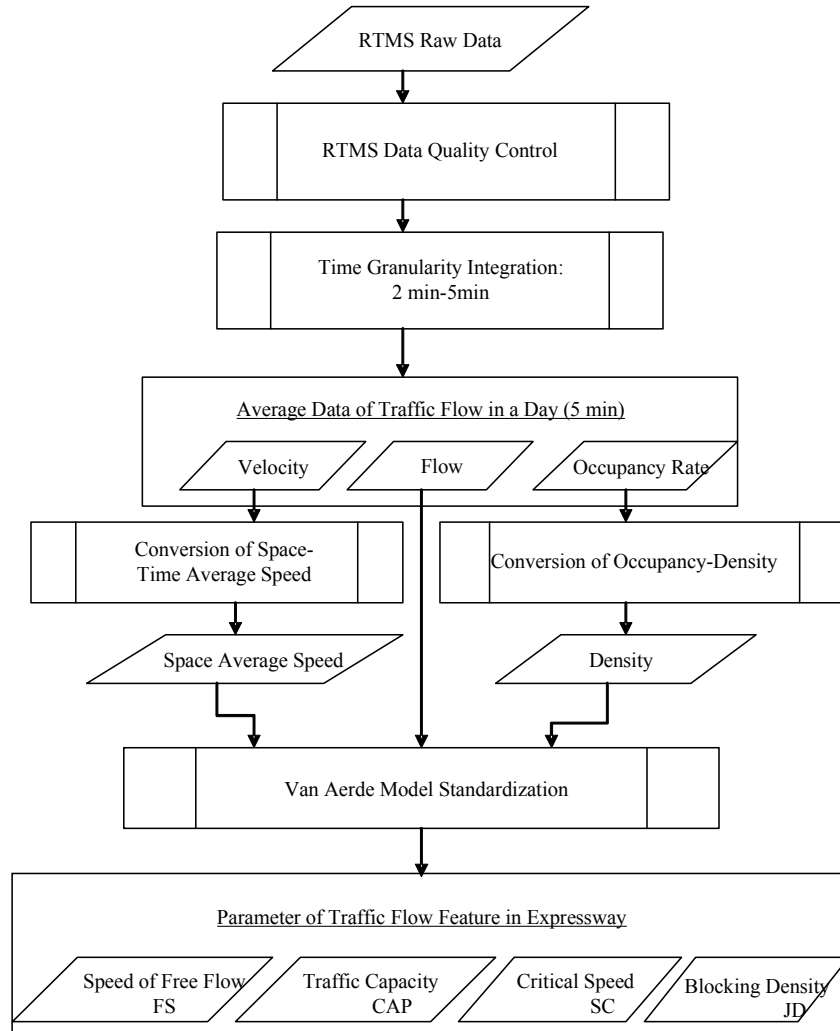


Figure 1 : Flow chart of determining affecting parameter of traffic flow

**Construction of disconnected traffic flow equation in college mathematical modeling**

When the traffic flow density function  $\rho(x, t)$  is disconnected in establishing model, this is common situation of traffic flow in college mathematical modeling system. In the process, there will be several discontinuous points which are expressed with  $(x, t)$  in building traffic flow model. Due to the phenomenon of disconnection, the discontinuous point  $(x, t)$  will form a discontinuous line in traffic flow plane, which is expressed with  $x = x_s(t)$  in building of traffic flow. Next, it is the analysis of discontinuous traffic flow equation that  $x_s(t)$  meets by using college mathematical modeling.

For any time  $t$  in any sections, the present state on X axis is isolated<sup>[4]</sup>. During the modeling, it is needed to analyze the vehicle’s changing situation of discontinuous line on front and back road. In the process of establishing traffic flow by using college mathematical modeling, the changing situation of vehicle’s number in a period on highway should be effectively analyzed. Among them, the period is expressed with  $(t, t + \Delta t)$ , the section of vehicle driving on highway is expressed with  $(x, x + \Delta x)$  and the approximation of vehicle’s number from a point  $x$  to the section in process of driving is expressed with  $q(x + \Delta x, t)\Delta t$  as well as the situation of the road is expressed with  $[x_s(t) - \varepsilon, x_s(t) + \varepsilon](\varepsilon > 0)$ . During the process of analysis, the length of the section should be taken into consideration. In establishing the whole equation, if the

length is shorter, inflow will equal to outflow and when the vehicles cross  $x_s(t) + \varepsilon$ , in  $(t, t + \Delta t)$ , the number of vehicles that vehicles outflow from the section is calculated by using traffic flow  $x_s(t) + \varepsilon$  minus inflow in  $x_s(t + \Delta t) + \varepsilon$ . Through the above calculation, the final vehicle's number in specific section on highway is obtained, i.e.:

$$q(x_s(t) + \varepsilon, t)\Delta t - p(x_s(t) + \varepsilon, t)(x_s(t + \Delta t) - x_s(t)) \tag{6}$$

The above expression of vehicle's number is divided by  $\Delta t$ , among which,  $\Delta t \rightarrow 0$  and the vehicle's outflow rate in a section in highway is finally calculated. The expression is as follows:

$$q(x_s(t) + \varepsilon, t) - p(x_s(t) + \varepsilon, t) \frac{dx_s(t)}{dt} \tag{7}$$

Then, calculate velocity of vehicle crossing  $x_s(t) - \varepsilon$  and the final equation is:

$$q(x_s(t) - \varepsilon, t) - p(x_s(t) - \varepsilon, t) \frac{dx_s(t)}{dt} \tag{8}$$

In the process of constructing traffic flow model, define  $\varepsilon \rightarrow 0$  and corresponding limit expression of  $\rho(x, t)$  and  $q(x, t)$  are expressed as follows:

$$\rho^- = \lim_{\varepsilon \rightarrow 0} \rho(x_s(t) - \varepsilon, t), \rho^+ = \lim_{\varepsilon \rightarrow 0} \rho(x_s(t) + \varepsilon, t) \tag{9}$$

$$q^- = \lim_{\varepsilon \rightarrow 0} q(x_s(t) - \varepsilon, t), q^+ = \lim_{\varepsilon \rightarrow 0} q(x_s(t) + \varepsilon, t) \tag{10}$$

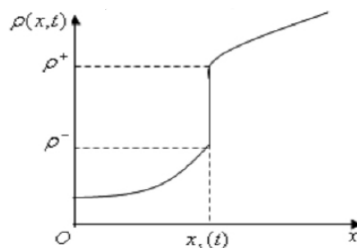
In specific section of highway, jump values of the density and flow of traffic flow  $\rho(x, t)$  and  $q(x, t)$  in discontinuous point are expressed as follows (the discontinuous point is expressed with  $x_s(t)$ ):

$$[\rho] = \rho^+ - \rho^-, [q] = q^+ - q^- \tag{11}$$

In the process of constructing whole equation, due to the section is shorter, the inflow equals to outflow. Define  $\varepsilon \rightarrow 0$ , the final equation can be got:

$$\frac{dx_s(t)}{dt} = \frac{[q]}{[\rho]} \tag{12}$$

The above equation is discontinuous traffic flow equation in discontinuous point  $x_s(t)$  in a section on highway by using mathematical modeling. In the equation, the calculation of  $[\rho]$  and  $[q]$  can be calculated by taking advantage of continuous traffic flow equation to finally obtain the limit of  $[\rho]$  and  $[q]$  in discontinuous point  $x_s(t)$  in a specific section. As Figure 2 show, it is changing situation of vehicles of density of traffic flow  $\rho(x, t)$  in discontinuous point  $x_s(t)$  in a section.



**Figure 2 : The Changing situation of vehicles of  $\rho(x, t)$  in discontinuous point  $x_s(t)$  on highway**

As Figure 3 shows, it is the selecting flow chart of relative algorithm in establishing traffic flow.

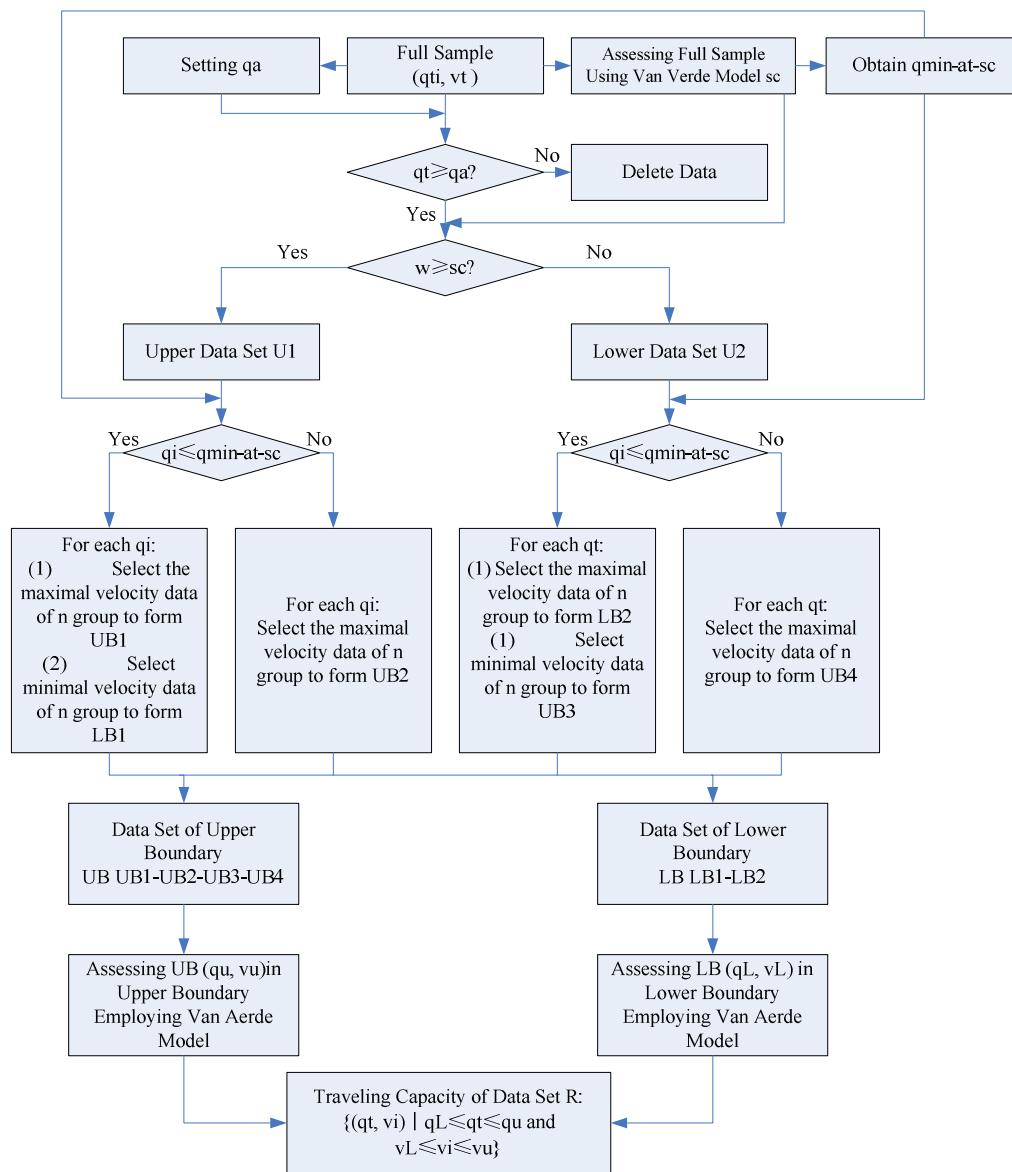


Figure 3 : Selecting flow chart of relative algorithm in establishing traffic flow

It is known through constructing the above continuous and discontinuous traffic flow equation that the model in the thesis mainly applied to the traffic flow in one-dimensional single lane<sup>[5]</sup>, i.e. the single lane in long road. During the traveling of vehicles, the lane can not be overtaken and there is no turnout. It also is sure that vehicles can not pull in or pull out from other lanes<sup>[6]</sup>. As Figure 4 shows, it is the flow chart of basic analyzing the construction of traffic flow model.

The construction of traffic flow model by using college mathematical modeling in the thesis completely follows the conservation relations among vehicles to further establish differential traffic flow model. At the same time, the ways of studying traffic flow model employed by the paper is to make use of continuous ways for building equation and finally, conduct effective exploration on situation of traffic lights model.

**ENLIGHTENMENT AND SUGGESTION ON THE IMPROVEMENT OF TRAFFIC FLOW MODEL**

Through above comprehensively analyzing and studying the construction of traffic flow model based on college mathematical modeling, there are three factors affecting traffic: flow direction  $q(x,t)$ , velocity  $u(x,t)$  and density  $\rho(x,t)$  of traffic flow and the thesis establishes continuous and discontinuous traffic flow equations by using college mathematical modeling. The above explains the main flow chart of constructing traffic flow model in detail. For the model, the defect lying in the process of establishment is the above traffic flow model is a perfect model and any traffic accidents will not happen in the model. Under the condition, if the head of the motorcade accelerates, the back vehicles will accelerate too and one motor can touch the tail of front vehicle. Therefore, the construction of the model has some unreasonable factors. On real highway, any drivers are not able to fully guarantee to response appropriately to relative velocity difference when he saw it

immediately<sup>[7]</sup>. In the study, in the creation of model, it is assumed that the emergency reaction of driver's and the stimulation factors are direct ratio and the emergency reaction will delay a period after the occurrence of accident. On the basis, the constructed model will be more realistic and more reasonable and feasible.

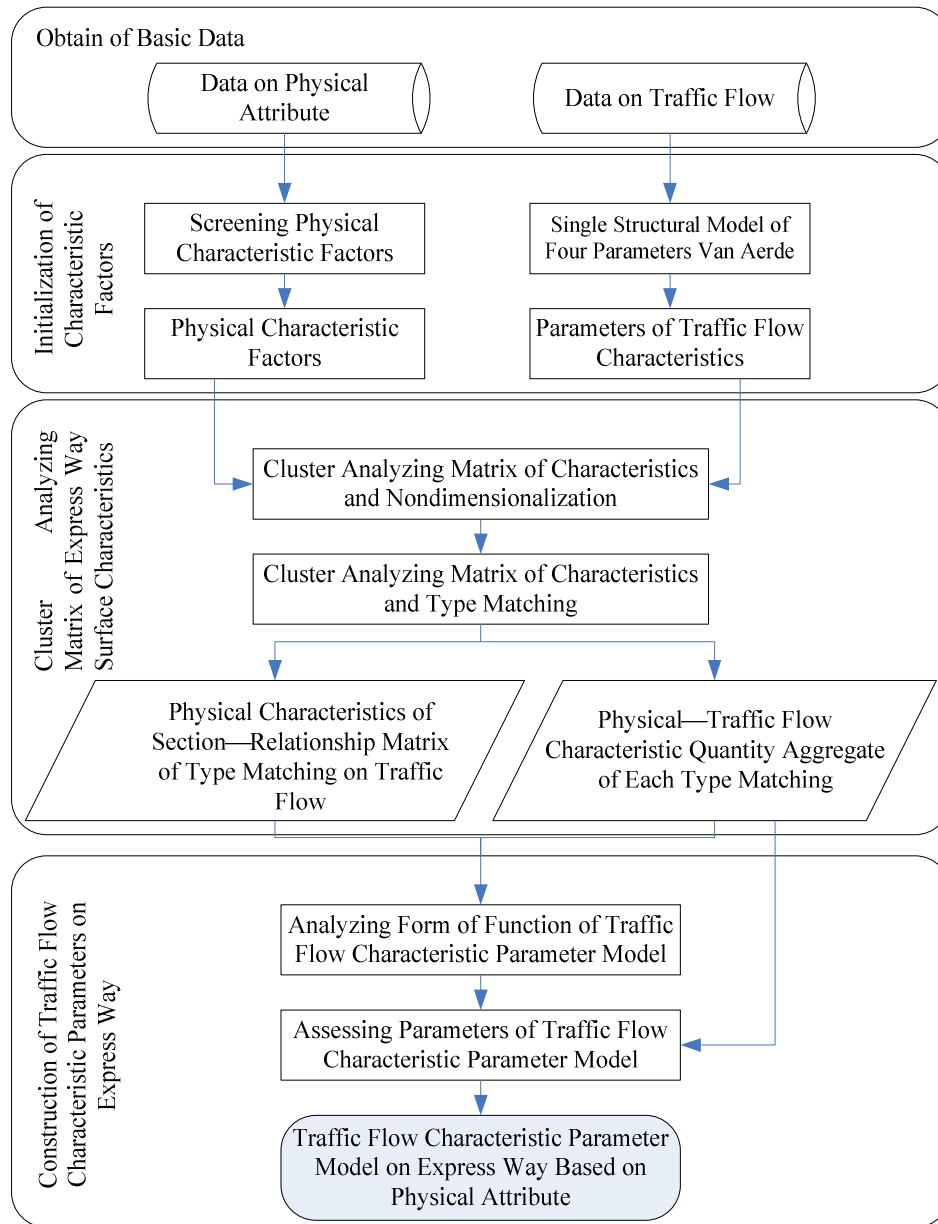


Figure 4 : Flow chart of basic analyzing the construction of traffic flow model

### CONCLUSIONS

According to the continuously increase of traffic flow on highway in recent years, the thesis puts forward reasonable motor motion theory. The research mainly employs college mathematical modeling to construct traffic flow model. During the course of modeling, the highway is taken as a pipe, motorcade as fluid in the pipe and the form of motorcade is the movement of fluid in mathematical modeling. The construction of traffic flow model by using college mathematical modeling in the thesis fully follows the conventional relation among vehicles to further establish calculus traffic flow model. In the meantime, the traffic flow model in the research mainly uses the way of discontinuous line to set up equation and conduct efficient exploration on the occurrence of traffic lights model. During the process of constructing traffic model, it is needed to study variables that affect traffic per second on highway. The variables are mainly composed of flow, velocity and density of traffic flow as well as the influence of correlation among the three variables on traffic. In course of constructing traffic flow model, the research takes calculus in higher mathematics as theoretical support and study base and views motors on the road as continuous particles to further establish traffic flow model.

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