

# Research on the Impact of Road Construction on Traffic Congestion

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**Abstract**—With the accelerated process of urbanization, the construction of urban transportation infrastructure needs to be improved. The operating areas of the construction projects become the traffic bottlenecks, which are the trouble spots of congestion and accident. According to study the impact of road construction on traffic, we could evaluate traffic characteristics and service level of construction site, and propose the improvement measures to introduce traffic through analyzing current problems, road conditions, changing traffic environment. Based on the actual traffic situation, this paper proposes a model of the impact of road construction on road traffic capacity, and puts forward specific measures to improve the capacity of road traffic.

**Keywords**—Road construction; regression; construction time; construction distance.

## I. INTRODUCTION

In recent years, city of Wuhan has accelerated the pace of urban infrastructure construction, and gradually improved the urban road network structure. However, the scale and speed of road construction can not meet the growing traffic demand. The most obvious phenomenon is that Wuhan is a construction site concluding more than 5800 small sites. A large number of vehicles and pedestrians go across those sites which caused crowded scenes to be presented seriously.

Road construction and its impact on traffic congestion has been a hot topic for research on this field. For example, a number of scholars in China and abroad studied the cases in major cities in China.<sup>[1-10]</sup>

This paper analyzes systematically and comprehensively about the status and characteristics of road construction in Wuhan, provides decision-making reference and theoretical basis for the scientific planning of urban infrastructure construction, and promotes to build an urban comprehensive transportation system, which is compatible with the process of modernization of Wuhan, sustainable development, energy efficiency. Through the analysis of the adverse effect of typical regional traffic construction, it helps to make scientific decision for many other cities' transportation construction projects. In the long run, it helps to propose scientific and forward-looking urban planning, improve urban residents' living quality and environmental level, and promote urban sustainable economic and social development.

## II. DATA

From the Auto Navi traffic information publishing platform, we collect data about the status of road construction till December 2015, including the road name of construction section, the distance of construction section,

construction time and the average congestion index. Statistical results include 10 urban areas from a total of 64 urban area samples. After removing the outliers, there are 61 samples remaining.

We classify those 61 samples to 10 districts such as Wuchang District, Hongshan District, etc. From TABLE 2-1, we could see Hongshan District has the longest construction distance and the longest construction time, but the average congestion index ranged fourth, lower than Jiangnan District and Jiang'an District. The average congestion index of Dongxihu District is the smallest of all, ranked the second distance of the road construction and the construction time is not very long.

TABLE I. THE COMPARISON OF ROAD CONSTRUCTION IN MAIN CITY AREAS

District	Distance (km)	Construction time (hundred days)	Average Congestion Index
Wuchang District	1.15	20.27	1.5
Hongshan District	33.5	55.47	1.37
Jiangnan District	3.38	14.34	1.45
Jiang'an District	3.29	14.62	1.4
Hanyang District	2.25	7.13	1.37
Qiaokou District	2.54	3.74	1.35
Qingshan District	0.05	0.83	1.24
Caidian District	3.69	4.02	1.24
Dongxihu District	29.86	6.33	1.21
Jiangxia District	5.88	18.1	1.23

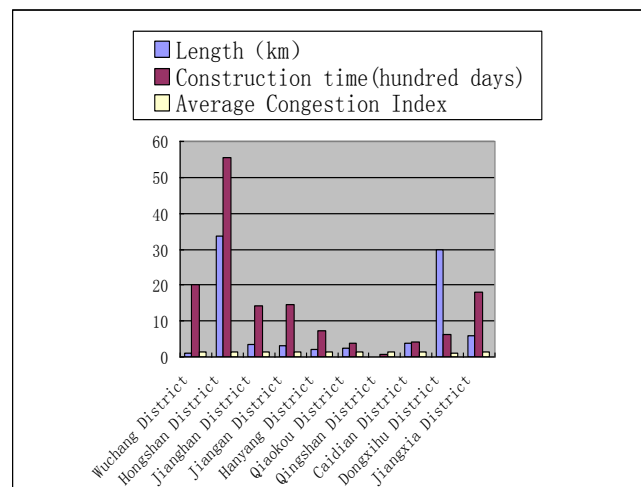


Figure.1. The Comparison of Road Construction in Main City Areas

### III. REGRESSION MODEL

Regression analysis method applies inertia principle of the development of things, to establish the model of correlation between the independent variables which influence urban road congestion index and the dependent variable of urban road congestion index. In view of the Scatter plot of urban road congestion index (s) and road construction distance (D), and the Scatter plot of road congestion index (s) and road construction period (L), we found that urban road congestion index (s) has good correlation with the road construction distance (D) and road construction period (L). This paper establish the corresponding regression model with regarding road construction distance (D) and the construction period (L) as the independent variables, regarding urban road congestion index as the dependent variable. Before we start the research, we suppose the road construction distance (D) and the construction period (L) are independent. The specific steps are as follows:

#### A. Collecting Sample Data, Eliminating Outliers

From the 64 samples collected, there are 3 special samples from the statistics. They are Xiongchu avenue Jia Yuan Lu to Mei Shan overpass road construction (12 kilometers), Huangpi District of Huangtu highway Changxuanling to Qianchuan Island (26.3 kilometers), Shipailing to high Avenue Jiayuan road sections (12.6 kilometers). We remove those three abnormal outliers, when doing research on the relationship between congestion index and construction distance, construction time, finally it remains 61 samples.

#### B. According to the Preliminary Analysis of the Scatter Plot, Select the Appropriate Regression Model

According to the linear relationship between S and L after excluding outliers, and the precondition of the hypothesis that the L and D are independent, we can know that there is a linear relationship between s, L and D. The model can be established like the following

$$s_i = b_0 + b_1 L_i + b_2 D_i \quad (1)$$

$s_i$  is the average congestion index of the i district,  $L_i$  and  $D_i$  represent the total distance and total duration of this district respectively. However, in real life, there are many other factors accounting for road congestion, besides of construction. We use variable  $\mu$  to indicate those factors, then the formula-1 can be written as:

$$s_i = b_0 + b_1 L_i + b_2 D_i + \mu \quad (2)$$

Among it, the variable  $\mu$  represents the random error term.

#### C. Checking and Correction, Get the final Acceptable Model

We import the data of 61 samples into SPSS software, the results of regression analysis are as follows:

TABLE II. SUMMARY OF MODEL

R	R Square	Adjustment of R Square	Estimation of Standard error
0.288	0.083	0.051	0.08967

TABLE III. REGRESSION COEFFICIENT

Model	Non-standardized coefficient		standardized coefficient	T	Sig
	B	Standard error	Trial version		
Constant	1.335	0.018		74.327	0.000
L	-0.016	0.016	-0.126	-0.998	0.322
D	8.486E-5	0.000	0.251	1.988	0.052

TABLE IV. Variance analysis

Model	Sum of squares	df	mean square	F	Sig
Regression	0.042	2	0.021	2.618	0.082
Residual	0.466	58	0.008		
Total	0.508	60			

(1) Given the Significant level  $\alpha = 0.05$ , the critical value  $F_{\alpha} = 2.76$  by searching in the F distribution table when the degree of freedom is (2,58), the result from the Variance analysis table  $F = 2.618$ ,  $F = 2.618 < F_{\alpha} = 2.76$ , it means that the regression equation:

$$\hat{s}_i = 1.335 - 0.126L_i + 0.251D_i \text{ Not significant}$$

(2) Given the Significant level  $\alpha = 0.05$ , The probability P of T value of the regression coefficient L and D were both greater than the significant level. So accept the null hypothesis of t test. In other words, the explanatory variables L and D in this model are not significant at the level of 95%. Thus, we choose to adopt the linear regression analysis through origin. Setting  $\mu = 0$  in formula 1, we get:

$$s_i = b_1 L_i + b_2 D_i \quad (3)$$

We import the data of 61 samples into SPSS, and the results of regression analysis are as follows:

TABLE V. SUMMARY OF MODEL

R	R Square	Adjustment of R Square	Estimation of Standard error
0.772	0.596	0.582	0.87225

TABLE VI. REGRESSION COEFFICIENT

Model	Non-standardized coefficient		standardized coefficient	T	Sig
	B	Standard error	Trial version		
L	0.621	0.130	0.424	4.774	0.000
D	0.002	0.000	0.509	5.735	0.000

TABLE VII. VARIANCE ANALYSIS

Model	Sum of squares	df	mean square	F	Sig
Regression	66.118	2	33.059	43.452	0.000
Residual	44.889	59	0.761		
Total	111.007	61			

Estimate of regression coefficient:

$$\hat{b}_1 = 0.424$$

$$\hat{b}_2 = 0.509$$

Thus, the model can be estimated as:

$$\hat{s}_i = 0.424L_i + 0.509D_i$$

$$se = (0.130) \quad (0.000)$$

$$t = (4.774) \quad (5.735)$$

(1) Given the Significant level  $\alpha = 0.05$ , the critical value  $t_{\alpha} = 1.67$  by searching in the t distribution table when the degree of freedom is 58, the results from the Variance analysis table are greater than the critical value 1.67, so reject the original hypothesis. It means that the two explanatory variables L and D in the model are significant at the level of 95%, and pass the significance test.

(2) Given the Significant level  $\alpha = 0.05$ , the critical value  $F_{\alpha} = 2.76$  by searching in the F distribution table when the degree of freedom is (2,58), the results from the Variance analysis table is  $F = 43.452$ , cause  $F = 43.452 > F_{\alpha} = 2.76$ , so reject the original hypothesis. It means the regression equation is significant, and the two explanatory variables L and D in the model are significant at the level of 95%, and pass the significance test.

So the formula is as follow:

$$s_k = 0.424l_k + 0.509d_k$$

#### IV. CONCLUSION AND SUGGESTION

According to the models above, construction time and construction distance have a positive impact on urban road congestion. The longer construction distance, the more intensive of the construction, the more construction equipment will take, the more space of road will be occupied, eventually more negative influence on drivers. Similarly, for construction time, the longer construction time, more fatigue and impatience of the driver, and higher chances for traffic accidents.

In order to prevent the impact of road construction on road congestion, there are several suggestions:

##### A. Scientific Planning and Improve the Level of Traffic Flow Prediction

Planning highway network construction reasonable, make some road construction, especially the repetitive construction reduced or even avoided, so that decrease the adverse effects caused by road construction; In view of the characteristics of some engineering projects, such as the

project with long distance construction or long duration construction, we suggest to adopt a phased construction; Adopt scientific ways, such as using computer simulation tools to evaluate comprehensively and accurately on the impact of the road construction, and develop a more reasonable construction plan.

##### B. Strengthening Construction Organization and Management Level According to the Characteristics of each District

According to the research results, develop implementation plan base on the different characteristics of each district. For example, Hongshan district is the most influenced by the road construction, we'd better strict the construction management, try not to delay under the premise of quality assurance, minimize the negative impact of construction as much as possible. In addition, compared to construction distance, construction time is more influenced to the traffic. Therefore it is necessary to pay more attention on the construction project management.

##### C. Developing Traffic Organization Plan Scientifically and Reasonably

The implementation of traffic organization during the urban road construction can effectively reduce the impact of road construction on urban traffic. Through scientific traffic organization, diversion treatment is used to urban road construction, in order to ensure the traffic capacity of urban road. As we can't be able to solve the problem absolutely caused by road construction, so we should coordinate actively with relevant units and business consultations, support construction from the overall situation, to ensure that complete the construction smoothly and rapidly.

##### D. Traffic Control on Urban Road Construction

During urban road construction, implement the policy of traffic flow, and guide various vehicles to access according to the scale of road construction. Release information of urban road construction actively, so that implementing a real-time control of traffic. During the construction of urban road, control relevant vehicles' travel time, to avoid a large number of vehicles appearing on rush hour at the same time.

##### E. Manage the Urban Road Construction Site

In the management of urban road construction site, it is necessary to strictly regulate the operation procedure of construction department. The road construction departments need to place the traffic warning signs and instruction symbol in accordance with the regulations, to ensure vehicle drivers notice the construction period in time.

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