

# Analysis of Strategies to Improve Traffic Conditions in the Ancient Urban Area of Suzhou<sup>\*</sup>

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**Abstract:** In this paper, the authors first analyse the problems existing in the situation of land use, structure of travel mode and road network by applying the basic principle of traffic engineering and system engineering methods. Then, the authors make it clear the strategies to be adopted for solving the existing traffic problems in the ancient urban area of Suzhou(AUAS), namely insisting on the goal-based strategy; the strategy to develop the public transit system in priority and decreasing the demand on cars from the view point of land use strategy. On the basis of such analysis the authors put forth proposals about major measures to be taken to improve traffic conditions of the AUAS, such as construction of express artery ring around the ancient city, appropriate transformation of the roads in the AUAS and rational distribution of car parking areas at the outskirts, which are of positive significance in guiding the protection of the AUAS and transportation construction. In this paper, specialized software is used to establish criteria for the construction scale and extent analysis and evaluation of the ancient city construction project, which is of some reference significance to the transformation of old urban areas in other cities.

**Key words:** ancient urban area of Suzhou, traffic problems, strategy

Suzhou is among the first group of National Famous Historic Cities announced by the State. The city-wall building method, layout of the city, road-and-river system, architectural style and water-lane feature of Suzhou are of special values in the history of city construction of China. The AUAS is the part of urban area within the outer moat, consisting of Pingjiang, Canglang and Jinchang administrative districts. Its total area is 14.14 square kilometers and it has a population of 303 200 at the end of 1997 with a population density of 21 400/km<sup>2</sup>. Thanks to the gradual adjustment of the land for industrial use and accelerated reform of dangerous and old buildings in recent 10 years, the AUAS has taken on an entirely new look. However its development is also facing challenge. In current years the development and resultant changes of the city by far greater than those occurred in any period after the founding of the People's Republic of China and even any one in the history. Therefore the stable structure and features which have lasted for over 1 000 years are subject to great changes<sup>[1]</sup>. One big problem which has been brought about is that of traffic that prevents the overall potentialities of the AUAS from being made full use of. In view of such a situation, the authors hereby not only put forth proposals about analysis of strategies to improve traffic conditions in the AUAS but also expect that it is of significance in guiding the protection of the AUAS.

## 1 Radical Traffic Problems

### 1.1 Unreasonable land-use activity allocation

In accordance with the urban master planning of Suzhou (UMPS) and for the purpose of effectively protecting the AUAS, “dispersal of inhabitant”<sup>[2]</sup> has been considered the major measure. Hence the construction of the new area in the outskirts has been accelerated some inhabitants of the AUAS have removed to the new area and the target has been set that the total inhabitants of the AUAS shall be gradually reduced to below 250 000 through adjustment. In the process of actual implementation of the UMPS during recent years, two phenomena occurred. One is regrouping of inhabitants due to passive removal from the AUAS resulted from pulling down of old houses in course of renewal of the AUAS and municipal construction and active removal out of the inhabitants' own requirements. The other is the large-scale commercial development of real estate and a huge quantity of activities were, have been and will be launched in the AUAS owing to the attraction of such commercial development there, which has increased the dependence of inhabitants outside the AUAS on it. Generally speaking, the dispersal of inhabitant from the AUAS has determined that the existing trip distribution is of a significant centrality and the trip distance is extraordinary long. For example, the

population and land occupied of the AUAS constitute 1/5 and 1/9 of those of the whole city respectively. However about 4/7 traffic is concentrated there among which nearly a half of the traffic is for entering into or going out of the AUAS.

It can be seen that unreasonable land-use activity allocation which leads to the job opportunity mismatching inhabitants inside and outside of the AUAS and over-concentration of the functions of the center as commerce is the primary cause. It can't solve the traffic problem by just controlling the total quantity of inhabitants of the AUAS without making fundamental adjustment of the land-use intensity and layout of functions of the city. On the contrary, it may even tend to deteriorate the conditions. Hence it may be said that the traffic demand hasn't been fundamentally alleviated in the course of dispersal of inhabitants.

## 1.2 Unreasonable travel mode

Affected by factors such as the conservation of the AUAS, the removal of the municipal government, construction of Suzhou New Area and Suzhou Industrial Park and the development of export-oriented economy, the residence areas outside the AUAS become more and more attractive while the AUAS remains to be the first choice of the "old natives of Suzhou". In 2000, the senile people over 60 of the AUAS made up about one fourth of the total population, much higher than 17.1%, the average percentage of the whole city. According to the characteristics of the social-space of the AUAS, it would be better for most residents here to go out by walking or taking buses. However the fact is that now the people travelling by public transit only account for 33% of the total, 3 percent lower than the average of the whole city which is very low in comparison with other neighbouring cities. It shows that public transit fails to have developed as it should and such a situation is not in compliance with the requirements of development of Suzhou as a whole.

The results of analysis of related statistic data show that the previous 10 years witnessed rapid development of road construction of Suzhou. The roads have increased by 2.15 times in total length and by 3.73 times in area. However the road construction was concentrated in the New Area and Industrial Park Area of Suzhou. The development of traffic in the AUAS has always been slow. As the existing streets and roads within the AUAS are small in size except several main roads including Ganjiang Road and Renmin Road and most of them are below 14 meters in width, it is difficult to arrange more public transit routes there, which results in the unreasonable layout of public transit network featuring: ① Low density of public

transit network and high repetition coefficient. The density of public transit route network of the AUAS is only  $1.75 \text{ km/km}^2$ , much lower than  $3 - 4 \text{ km/km}^2$  as required by the relevant National Standard for the downtown area of a city. ② The repetition coefficient is 3.74, higher than that of the average (2.66) of the whole city. The routes are concentrated along Ganjiang and Renmin Roads and along some sections of them, there are over 10 public transit routes arranged.

The structure of travel mode of Suzhou is in the stage of transition now. As the competitive force of public transit is poor, travel by cycles and walking are changing into travel by motorcycles and power-assisted cycles and mainly into travel by motorcycles in the AUAS. As a result, the traffic volume by motorcycles in the AUAS has increased to about one third of the total traffic volume by automotive vehicles, a higher proportion than the average of other areas of the city. In such a case the existing road resources can't be made full use of. Because the municipal government of Suzhou has adopted the policy of limiting the development of motorcycles and fuel-firing power-assisted cycles, the increase of the same has slowed down. However due to the steady increase of the people's income and promotion of the macroscopic policies of the state, the AUAS is facing the potential pressure of rapid increase of private cars. At the end of 1999, the private cars of the AUAS totaled 6 869 PCU i.e. 1.8 PCU every 100 households. The average annual growth rate in recent years is over 30%, higher than that of roads. Though the purchasing power of the inhabitants and the proportion of the crowd fit for possessing private cars to the population of the AUAS are lower than other areas, the traffic tends to become even more crowded as the capacity of roads and environment of the AUAS is lower than that of other areas. This indicates that there is an urgent need to build up a new-type traffic system in the AUAS and even in the whole city and it admits no delay to enhance the competitive edge of the public transit system.

## 1.3 Disordered urban road network

The experience obtained in developing the road traffic in the AUAS in recent years shows that the traffic problem of the AUAS can't be fundamentally solved by taking engineering measures. Though such roads as Ganjiang Road, Zhongjie Road, Yangyu Lane, Dongda Street, Xinshi Street and Zhuhui Road in the AUAS have been broadened or extended from the exterior to the interior successively and the traffic network of "Criss-cross Streets plus Ring Roads" has been built up (See Fig.1), however, judging from the

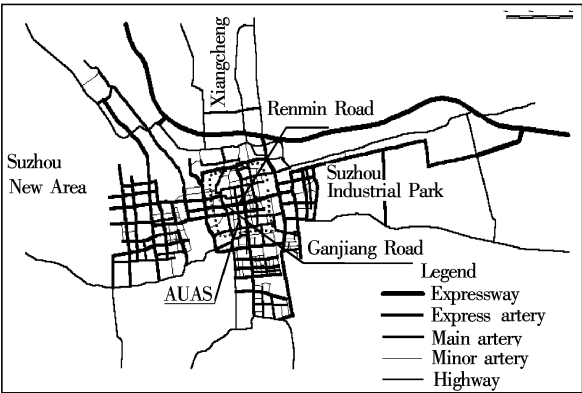


Fig. 1 Current urban road network

actual effect, the traffic facilities already provided are still insufficient and the networking level has to be further raised as the degree of motorization of the city is heightened so quickly. To solve the traffic problem of the AUAS, the state council clearly requests in its written reply that efforts shall be made to accelerate construction of ring roads. However due to various reasons the construction of ring roads lags behind. Except the Chezhan Road and Nanmen Road, all other related roads are below 18 meters in width and have limited capability for vehicles to pass through, among them, Tangfangwan and Beiheyang Roads are so narrow that motor-driven vehicles are absolutely unable to pass through them. The express ring road outside the AUAS is not in sound condition either. Thus for contact and communication between other areas, people still have to cross the AUAS along the main roads (Renmin Road and Ganjiang Road), making the problem that the traffic facilities provided are insufficient more serious. Even for such main roads, their vehicle-passing-through ability is greatly reduced due to small distance between intersections resulting from densely-distributed streets and lanes of the AUAS and unreasonable timing of signals. Taking Renmin Road and Ganjiang Road for example, while the volume of traffic of motor-driven vehicles have increased to 21 200 PCU/d and 35 400 PCU/d respectively, their service levels have dropped to below Class C and Class E. Traffic on Ganjiang Road is the most crowded and the vehicles' speed has been reduced to below 18 km/h, always causing considerably long delay.

2 Basic Strategies

2.1 Goal-based evaluation methodologies

In conserving the ancient urban areas, the cities of foreign countries pay more attention to the planning and construction of traffic facilities of the ancient urban areas, take design of traffic facilities and construction of environment as the mainstay of renewal of ancient

urban areas and therefore avoid the vicious cycle of “More roads, more vehicles”. To follow the principle of “implementing overall conservation of the style and features of the ancient urban area” efforts shall be made to ensure coordination of conservation of the AUAS with planning and construction of traffic facilities and put both conservation of the AUAS and construction of traffic facilities on the right track of sustainable development. In the plan for the AUAS consisting of 54 blocks detail planning, “residential, tourist and traditional commercial functions” have been incorporated as the goals of construction of the AUAS which will be fulfilled by effecting conservation and renewal of different levels. Thus a planning document with high operability is provided for conservation of the AUAS. In solving the traffic problem of the AUAS, the defined functions of the area shall be taken as the major goals guiding the construction of traffic facilities of the area. Thus it becomes clear that the development of communications of the AUAS shall meet the requirements in three aspects. Firstly it shall meet the requirements of the inhabitants of the AUAS for travelling and create a nice traffic environment for walking. Secondly it shall meet the requirements for development of tourism and build up a comfortable and convenient tourist traffic system. Thirdly efforts shall be made to develop public transit linking the AUAS with outer areas, increase the accessibility of the centre of the city and it is easy for passengers to reach the centre of the city by taking public transit facilities. It is expected that finally a traffic system that is sustainable, reasonable in structure, balanced between supply and demand and humanized will be built up in the AUAS (See Tab.1).

2.2 Taking transit as the mainstay

For the whole city, it is necessary to first establish the leading position of public transit before booming of private-car traffic. Efforts shall be made to conduct research on rail transit system, scientifically plan for the rail transit network and build up and perfect the urban public transit system which takes rail transit and buses as the mainstay and taxis as the auxiliary means, has strong competitive force, is high in quality and has a high rate of coverage. It is also necessary to eliminate the constraints imposed by existing administrative factors, plan for the public transit system of the city as a whole; promote reform of the public transit system, promote industrialized operation of public transit and raise the operating efficiency of the public transit system. Conditions shall be provided to guide those long-distance travelling by cycles to do so by buses. Ridership system shall be established in the whole city

for change from cycles to buses and vice versa. The investment in public transit shall be increased and

efforts shall be made to increase the proportion of those

Tab.1 Goal-based evaluation methodologies

Goals	Goal No.1	Goal No.2	Goal No.3
	Fine traffic facilities for walking	Comfortable tourist traffic	Increase the accessibility of the centre of the city
Development goals	Conservation and construction of fine residential environment	Accelerating the development of tourism and the third industry	Building up rational urban commercial system
Measures for conservation	Reducing the population density	Prohibiting construction of man-made landscape	Controlling density of public buildings
Users of traffic facilities	Inhabitants of the AUAS	Tourists	Inhabitants outside the AUAS
Features of distribution of traffic facilities	Uniformity	High degree of order	High efficiency
Requirement for traffic quality	Safety, comfort	Comfort, convenience	Fast, comfort, efficient
Recommended travel mode	Walking, transit, cycles	Transit, walking	Taking transit as the mainstay
Measures for construction of traffic	Appropriately increasing the area of roads	Transit loops for tourism, improving traffic facilities for walking	Enhancing public transit for linking interior of the AUAS with the exterior

travelling by public transit shall be increased from 6.44% at present to 23% in 10 years. The public transit in the ancient urban shall be developed even more quickly and the above proportion shall be increased to about 24% for the AUAS i.e. there shall be an annual growth rate of 1% – 1.5%. The connection between social groups and bodies through public transit shall be strengthened so as to make travelling by public transit the main traffic mode for people to come into and go out of the AUAS.

2.3 Optimizing land-use activity allocation

Judging from the city as a whole, the number of private cars is increasing quickly. However it is still at the initial stage of development. In the coming future the policies on car consumption and reforms of fees and taxes will be promulgated successively to encourage people to purchase and use cars. The idea on development of private cars shall be: encouraging well-off families to purchase cars in the near future, amending the policies on development of cars in accordance with actual conditions of the traffic capacity and environmental capacity upon a specified date in the future. After all the total number of private cars shall be controlled within the threshold value (150 PCU/1000 people) in a long time to come.

In planning construction of the AUAS, great attention shall be paid to the traffic of cars. The strategy of prudent development shall be adopted for the near and long future. The results of calculation of the traffic capacity and environmental capacity of the AUAS show that the owning rate of cars shall be controlled below 60 PCU/1000 people for a long term. According to the development plan for the AUAS, the strategy on development guided by walking and public transit shall be adopted. It is expected that by rationally arrangement of the social space, traffic space

and residence space of the area, the traffic system with public transit playing the main role, cars and other traffic modes developed homogeneously will be formed. In this connection, the planning and construction of parking facilities shall be taken as an important measure to guide proper land-use activity allocation for cars and reasonable policies on development of parking lots in the AUAS shall be worked out to guide the land-use activity allocation of car owners in the AUAS.

3 Pertinence Solutions

3.1 Accelerating construction of high-speed traffic system and unclogging peripheral traffic of the AUAS

Along with the adjustment of administrative divisions of Suzhou, the expansion of the urban space of Suzhou has changed from the original “one body and two wings” to today’s “cross” type. The volume of traffic passing through the ancient urban space will unceasingly increase as the peripheral land used is continuously extended, which sets even higher requirements for the development of road traffic of the AUAS. For the purpose of avoiding the interference by the traffic between the interior and exterior of the AUAS and restoring the traffic order of it, it is necessary to build up the traffic rings forming peripheric paths around the AUAS. First the rehabilitation and construction of the medium ring shall be accelerated. On the basis of optimization of the plan for the road network of Suzhou city, the UMPS shall be adjusted, the “Nine-Square” type express artery system determined and the layout of “Two Horizontal and Four Longitudinal” express arteries network reformed and built up as soon as possible. Besides the medium ring shall be extended outwards to connect with the major inlets and outlets of expressways so as to act as the major passage for switching between inner and outer

traffic of the city. The rings of the AUAS complete with matching facilities shall be built. Many related roads such as Changxu Road, Panmen Road, Nanmen Road, West Fengmen Road, North Xiangmenqiao Road, Beiyuan Road, Pingqi Road and Guangji Road shall be appropriately broadened and rehabilitated to increase the vehicle-passing capacity of the rings of the AUAS and effectively bypass the traffic flow in the periphery of the AUAS which will otherwise pass through it. A traffic artery which coordinates with the inner tourist ring of the AUAS and concurrently has the function of serving as a scenic spot itself shall be completed(See Fig.2). The relations between the express artery ring

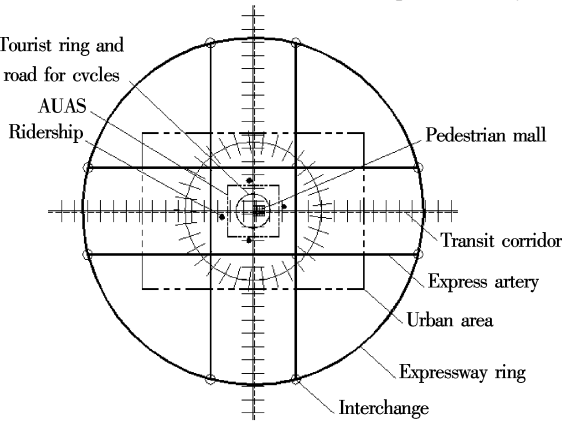


Fig.2 Conceptual transportation network

and main artery ring shall be well handled. The double rings system is an integral body, complementing each other in function. Neither can replace the other. The test results of the plan show that the overall service quality of motor-drive vehicles on the medium ring road is of about Class C in average and that on the ring road, above Class B. It indicates that the peripheral ring road system of the AUAS can effectively bypass a huge quantity of traffic flow which would otherwise pass through the AUAS.

3.2 Appropriately rehabilitating the roads of the AUAS, focusing on providing road space for development of public transit

Rehabilitating roads is an item to be incorporated in the plan which is easy to cause disputes and difficult to decide on. To avoid planning blindly, the method featuring combination of qualitative and quantitative analysis is used. As shown in Fig.3, the optimum solution for the construction intensity of the roads in the AUAS is obtained by establishing the target functions of the level of traffic load to the intensity of conservation and construction of the AUAS and then gradually increasing the projects and unceasingly carrying out network traffic distribution and analysis and evaluation(See Tab.2). The rehabilitation of roads in the AUAS will provide sufficient road space for

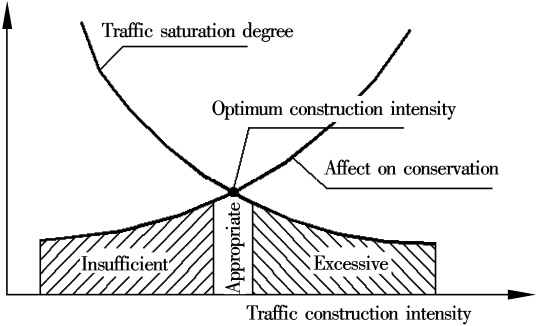


Fig.3 Optimum construction intensity

operation of mass traffic. Through rehabilitation of roads, public transit routes shall be reorganized with even greater flexibility by suiting the measures to local conditions to increase the public transit network density and reduce the non-linear coefficient and repetition coefficient of the public transit network of the AUAS.

Tab.2 Optimum road construction intensity

Objective of development of road traffic	The traffic quality of 92% roads shall be of class C; main roads shall be unobstructed; the bottleneck of traffic into and out of the AUAS shall be eliminated.
Requirements for conservation of AUAS	The setup of parallelism of roads with rivers shall be maintained; the traditional streets and lanes shall be preserved and the comfortableness of living shall remain the same.
Optimum road construction intensity	Large-scale pulling-down and construction shall be prohibited; the length of newly built roads shall be less than 1/20 of the total length of all the roads and the length of rehabilitated roads shall be less than 1/4 of the total length of all the roads.

The measures for rehabilitation of roads will mainly include: ① As the small residential districts in the west of the AUAS provide matching services to the Industrial Park (They provide 13 000 labors who take over half the work posts of the whole park), connection between the AUAS and the Industrial Park through traffic shall be enhanced. It is therefore proposed to extend West Suhong Road, Jinjihu Road and Airport Road to the Ring of the AUAS; ② It is hereby proposed to let Ganjiang Road cross the canal and further extend it westwards to connect with Dengwei Road so as to enhance the connection between the AUAS and Suzhou Area through traffic; ③ The roads within the AUAS shall also be appropriately rehabilitated, i.e. East and West Zhongshi, Northeast Street, Northwest Street, Taohuawu Street and Central Baita Road shall be broadened or extended. The test results of the plan show that ① Due to the completion of Peripheral Ring Road of the AUAS and effective traffic demand management measures, the traffic volume within the AUAS shows no significant increase in spite of improvement of traffic facilities of the AUAS which in normal cases would attract abrupt increase of

the traffic volume; ② There is an increase of 2 roads leading into and out of the AUAS and the number of lanes for motor-driven vehicles has increased from 38 to 46 and the average service quality has been raised from Class D to Class C; ③ The traffic load of the road network of the AUAS has somewhat dropped and the traffic quality of the main roads including Ganjiang Road and Renmin Road has been improved.

3.3 Enhancing construction of parking lot in the periphery of the AUAS and reducing the car-based traffic demand of the area

At present, the demand for parking vehicles around Guanqian Street is great. The existing parking stalls number is about 150. Except the underground parking lot of the People’s Bazaar, most vehicles are parked on roads and it is difficult to control traffic when vehicles are so parked. The plan for construction of park lots shall be prepared following the principle of putting parking demand under control, establishing a multi-form parking system and raise the turnover rate of parking stalls and releasing the press of parking on the AUAS to reduce the demand of the AUAS for car traffic, construction of parking lots in the periphery of the AUAS especially at places close to roads leading into and out of the AUAS shall be enhanced, taking into consideration the setup of bus stops and track transport stations. Besides, the ridership of cars, cycles and public transit vehicles shall be built up. To effectively release the press of road traffic and parking on the AUAS, information about parking shall be provided to drivers in a timely manner. By use of the information network and visual information panels, real-time information about operation of the parking lot in the AUAS shall be provided and forecast, vehicles shall be stopped from entering into or going out of the AUAS unnecessarily and drivers and passengers urged

to enter into or leave it by switching to take buses.

4 Conclusion

It is known to all that “Demand for traffic always tends to be equal to and surpass the supply to it”<sup>[3]</sup>. Therefore it is clear that the traffic problems of the AUAS can’t be fundamentally solved by construction of roads which is also unfavourable to conservation of the AUAS. To find out the balancing point between development of traffic and conservation of the AUAS is the basic starting point for improvement of the existing traffic conditions of the AUAS. By use of the theory and methods of systematic engineering, the paper analyses the existing problems and strategies, and puts forth proposals about countermeasures to be taken for solving the existing problems, focusing on construction of the express peripheral paths around the AUAS, rational use of the road resources in that area and planning and layout of parking lots. Having definite objectives in view and aiming at solving the problems by looking into the radical causes and apparent phenomena, it is expected that this paper will be of significance in guiding further conservation of the AUAS.

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苏州古城交通问题改善策略分析

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摘 要 本文应用交通工程学基本原理和系统工程学方法,分析了用地布局、交通方式结构和道路网络等方面存在的问题,明确了苏州古城交通问题改善的策略,即坚持以目标为导向的策略,优先发展公交系统的策略和从用地减少小汽车交通需求的策略,在此基础上,提出了包括古城外围快速环路构筑、内部道路适度改造、外围停车场合理布局等改善古城交通问题的重要措施,对保护古城和交通建设具有积极的指导意义.本文利用专业软件,对古城建设项目进行建设力度分析和评价来确定改造标准,对其他旧城改造具有一定的参考意义.

关键词 苏州古城, 交通问题, 策略

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