

Study of Construction of Bypass Roads with Consideration of Environmental and Energy Indicators

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Abstract. Determination of the radii of circular round-about highways and the corner of their unlocking is considered in the given article. To determine the radius of circular round about highways it is recommended to use the prime price of motor-car cargo transportations, taking into account the factor of their delivery acceleration for roads which provide different speed modes.

Keywords: highway, radius, circular round-about highway, road transport, charge, road network.

Conference topic: Roads and Railways.

Introduction

The existing practice of building both urban and country motor roads stipulates different approaches to assignment of geometric elements and traffic conditions for these roads. At the same time there are road sections and whole roads, in particular roundabouts (ring and semiring) on which traffic conditions, as well as geometric elements of motor roads, are different from urban and rural ones.

So, on suburban road sections the transport flow increases and its composition becomes heterogeneous, the traffic intervals decrease and the quantity of advances grows. Closely disposed common carrier bus-stops, contiguity and intersection with other motor roads are the main obstacles of transport flows. Therefore, drivers are forced to anticipate slowly moving cars, and to brake before crossings and contiguities. To general transport flow also has an authentic and dynamic character, which results in oscillations of traffic density and its composition, as well as in the origin of local and transit transport flows on roundabouts (ring or semiring motor roads).

Change of the transport flow according to the character of haulage, occurrence in the transport flow of slow-speed vehicles of special purpose is predetermined by the new requirements to the width of the roadway. At the same time, the growth of volumes of bus transportations and the quantity of passenger automobiles demands more courageous solutions concerning the determination of requirements to the equipment of bus-stops and specific recreational areas, parking-lots, pedestrian crossings located on different levels, as well as sidewalks, foot and bicycle paths.

Suburban motor roads should be adjusted for continuous transition of cars from the external to the internal road network and to further safe motion on the internal urban road network (Vasil'yev, Sidenko 1990).

Roundabout motor roads are one of the links between the internal and external highway networks.

Selection of a category of street or road as well as all its main specifications accordingly, at building of motor roads (urban and suburban) in compliance with the methods which had been developed earlier, was constructed taking into account the total perspective traffic density. However, considering the fact that for the purpose of effective work of a roundabout motor road it is built by the principle of simultaneous availability of both local and transit traffic flows, designing of its parameters should be dealt with as a difficult system. During motion by roundabout motor roads the transport flow is influenced appreciably by the motion of the passenger common carrier. At the same time, this traffic has proof laws for separate vehicles because this part of the flow is characterized by certain periodicity of trips (a timetable of trips and a constancy of routes).

For roundabout motor roads characteristic there is one of the major properties of a transport flow - interdependence of the vehicular traffic which is determined in their local interaction (Belyatynskiy, Taranov 1989). Most of all this interdependence is shown in the conditions of high traffic density of a transport flow when there is a jam in the traffic flow, which occurred on any road section (for example, due to a road accident or at a crossing or contiguity), is spread to significant distances. As a result, for a certain period of time the roundabout road ceases to function effectively, therefore the local transport is forced to return to city streets that in turn worsens the overall performance of the urban road-network.

It is possible to assert that the more the dependence of the traffic is, the bigger sections of a roundabout motor road should be considered.

It predetermines the necessity of developing a method of justification of parameters of roundabout motor roads, taking into account the mixed traffic of local and transit flows. Thus, the roads should ensure the continuous and safe dropout of

vehicles with high speed under conditions of sufficient high traffic density. Besides, it is necessary to develop measures for such motor roads concerning the track capacity growth at the expense of rational usage of traffic lanes.

At development of these measures, it is necessary to consider the following factors: the change of traffic density within days and year; the railroad traffic; fluctuations of traffic density of the local transport that is difficult to predict; road and transport adventures that arise periodically; closely disposed common carrier bus-stops and its heavy traffic.

Hence, roundabout motor roads, as well as transport flows, which are slid by them, can be attributed to difficult systems according to the following properties:

- availability of a considerable quantity of interconnected and interfacing elements;
- complexity of the function that the system executes and which is directed to the achievement of an objective in view of functioning;
- the capability of decomposition of the system into inter-systems, the purpose of functioning of which is subordinated to an overall aim of functioning of the entire system;
- interaction with the environment and functioning in conditions of random factors effect.
- The process of functioning of the system “highway – transport flow – environment” (H - TF - E) is an aggregate of actions of the system directed to the fulfillment of tasks, which are formulated for it, namely:
- according to the input data of the system (intensity and traffic composition, the purpose of drivers trips) on the basis of characteristics of a transport flow which appear in the course of their motion by roundabout roads to determine the initial parameters (intensity and speed), as well as the properties of this difficult system – reliability, accident risk safety, firmness, and the efficiency parameter;
- to determine such characteristics of the road at which there will be an absent probability of traffic jams origin under conditions of a high mean speed and traffic density;
- to ensure simultaneous availability of local and transit transport under conditions of convenience of freight delivery and passengers;
- To satisfy the requirements of a region in effective cargo and passenger transportations.

The efficiency parameters (EP) of the system is expressed by the maximum of traffic intensity and speed that the system can manage under conditions that both the safety and traffic convenience are not lower, and the expenses for providing the traffic convenience is not higher than in advance preset values (Uglenko, Uzhvieva 2014).

Mattering the EP and limiting conditions of decrease in the level of efficiency under unsatisfactory operating conditions of the system (failures, obstacles), it is possible to present the reasonable requests to reliability, firmness, accident risk safety, the quality of management and other main properties of the system (H - TF - E).

For calculations linked to the determination of requirements to the complex roundabout motor road traffic flow system, it is necessary to apply the methods of statistical modelling. When performing calculations separate elements of difficult systems are changed by equivalent schemes (algorithms).

The process of functioning of a roundabout motor road can be presented in the form of model (Fig. 1).

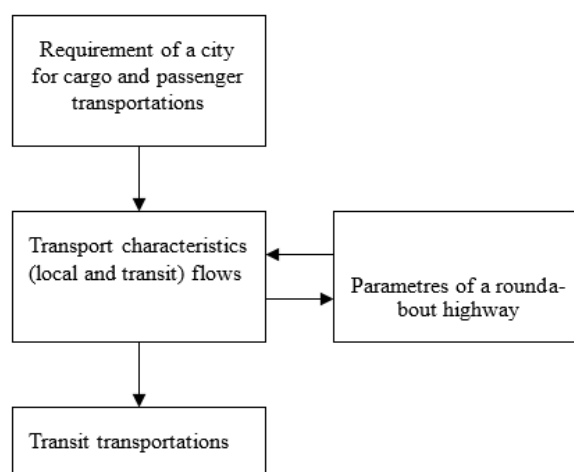


Fig. 1. Statistical model of roundabout motor roads functioning

The approximate statistical model of the process of complex system functioning (H - TF - E) is used for determining the efficiency of miscellaneous versions of the structure and a set of parameters, as well as selecting an optimal option. In this regard, there is made the first attempt of system synthesis (structure and parameters), although the solution of constructive character is not available yet.

The offered method of building roundabout motor roads is based on such parameters of system functioning as “motor road – transport flow – environment” (Fig. 1).

These fragments can be constituted in any possible method. Thus, the transport flow that goes out of one fragment

is an input one for the following. In the middle of each fragment there is a station limit which is part of a roundabout motor road which is being designed. Setting input parameters of system functioning and the characteristics of a motor road being designed by means of methods of simulation modelling of transport flows form the initial parameters of functioning of the system “motor road – transport flow – environment” (Table 1).

Table 1. Parameters of system functioning “Motor road – transport flow – environment”

Input data	Functioning by roundabout motor road	Initial parametres
Traffic density	Traffic intervals	Traffic density
Traffic composition	Conditions of changing the traffic lane	Traffic speed
The purpose of drivers (traffic route)	Traffic speed	Stability of parametres of complex system functioning (accident risk safety, reliability)
Road conditions and environmental factors	Road conditions (the plan, longitudinal, cross-section structures and others). Environmental factors (risk factors component and acoustic (noise) pollutions)	Efficiency parameter
Form an economic complex of the region and social living conditions of the population	Form the input data, as well as a roundabout road simultaneously with radial and other secondary roads	Are formed in the course of system functioning

Applying the methods of simulation modeling of (transit and local) transport flows by roundabout motor roads and using thus the principles of their research as difficult systems, there is a capability of multiple designing of such roads with decision-making concerning the correspondence of road conditions to requirements of transport flows that gives the chance to use effectively the roads during the entire perspective operation period (Belyatynskiy, Taranov 1988). The Main objective of building roundabout motor roads is improvement of an ecological position in settlements, decrease in level of road and transport accidents in streets, reduction of the cost value of transportations of transients and freight.

The justification of bypasses in settlements is based on the acting normative documents that consider the highway capability. However, the base document does not consider the ecological and energy parameters that influence the state of environment. Urgency of solving the tasks linked to the justification of building bypasses of settlements, taking into account the main ecological parameters and the improvement of ecological condition of the roadside area.

Besides, roundabout motor roads should collect a part of cars, which perform city transportations between separate boroughs. The actual task is selection of radii of bypasses. In the developed normative documents concerning selection of roundabout motor roads there are only general advisories, which comprise a list of possible versions of roundabout motor roads and the sequence of their economic comparison.

The greatest distribution to practice in designing motor roads was noticed on behalf of by bypasses, which are located on the verge of stand-by city territories. The predominant purpose of such accommodation is the distance of automobile roundabout roads from existing city buildings that allows using these bypasses as suburban motor roads on which higher speed of motion is ensured. Thus, very often the radius of by-pass depends on the size of the built up and stand-by city territory (Lobanov 1990; Ugnenko 2005).

The requirement for roundabout motor roads testifies the necessity of wider practical approach to the problem of accommodation of bypasses. Despite the departmental differentiation in fields of activity of city and suburban road organizations, designing of bypasses should be led according to plans for urban development for preliminary preparing of these bypasses for fulfilling the function of city motor roads (Andreev 1977).

The maximum usage of roundabout motor roads for city transportations is possible in condition of close accommodation of these bypasses from city buildings.

Method of determination of radii of bypasses in settlements with accounting ecology and energy parameters

Determination of radii of bypasses (distance) is brought together to comparison of speed during car trips on introduction motor roads with miscellaneous speeds. It is necessary to choose correctly the city part whose street network should be as much as possible exempted from a road transport.

For determination of radii of a bypass, it is recommended to use the ratio of time of cargo transportation traffic, taking into account the factor of acceleration of their delivery for motor roads, which ensure miscellaneous speeds.

To do this, they compare the speed of vehicles moving both through the settlements and by roundabout roads (Belyatynskiy, Taranov 1989).

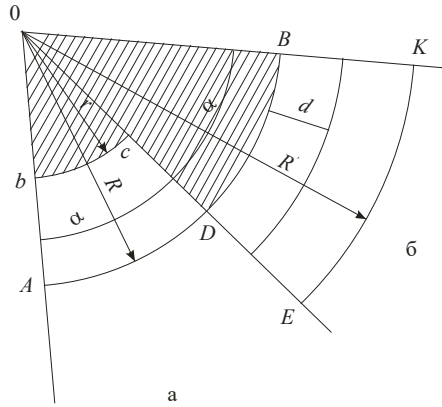


Fig. 2. The scheme concerning determination of radii of bypasses

Is efficient if

$$(R+r) \left[\frac{V_b}{\sum QP} \right] \geq R\alpha \left[\frac{V_o}{\sum QFP} \right] + (R-r) \left[\frac{V_b}{\sum QFP} \right], \quad (1)$$

where R – by-pass radius in a settlement in km; r – radius of the central part of a city which should be as much as possible exempted from road transport, km; V_b – speed on introduction road, km/h; Q – fuel costs per 1 km, l; P – special parameter which considers ecological parametres (ingredient and parametric pollution) P_{ecol} , and the parameter which characterises road parametres (operational parametres, geometric parametres of motor roads and local entities), P_r ; V_o – speed on roundabout road, km/h; α – the corner between introduction motor roads in radians; F – factor of using acceleration of cargo delivery.

From equality (1) we'll obtain the formula for determining the radius of by-pass:

$$R = \frac{r \left[\left(\frac{V_b}{\sum QP} \right) + \left(\frac{V_b}{\sum QFP} \right) \right]}{\alpha \left(\frac{V_o}{\sum QFP} \right) + \left(\frac{V_b}{\sum QFP} \right) - \left(\frac{V_b}{\sum QP} \right)}. \quad (2)$$

Radius calculation according to the formula (2) is performed by the method of consecutive approach (Ugnenko, Uzhvieva 2014). Firstly, they determine the radius without the coefficient F , then they determine the coefficient F , which is introduced into formula (3) for the repeated solution. The value of coefficient F is determined from the following expression:

$$F = 1 + f.$$

Further f – relative increase in volume of transportations:

$$f = \frac{\frac{2r}{V_b} - \frac{R\alpha}{V_o}}{\frac{l_e}{V_e} + K_n \tau}, \quad (3)$$

where V_b , V_o – traffic speed on city and roundabout routes, km/h; l_e , V_e – the length of a route and speed of motion of the car in mean service conditions, km, km/h; K_n – the factor of using the vehicle run; τ – total time for loading and unloading of vehicles during one trip per hour.

The radius of new by-pass (Fig. 2, b) is determined according to the formula:

$$R' = \frac{(R - R\alpha - d) \left[\frac{V_b}{\sum QP} \right] - (R + d) \left[\frac{V_b}{\sum QP} \right]}{\left(\frac{V_o}{\sum QP} \right) - \alpha \left(\frac{V_o}{\sum QFP} \right) - \left(\frac{V_b}{\sum QFP} \right)}, \quad (4)$$

where R – the radius of a by-pass designed in advance, m; d – the width of city territory which should be as much as possible exempted from road transport, m.

The specified formulas for determination of radii of by-passes take into account the parameters of only freight traffic. In general, passenger traffic also occupies a great volume of transportations. Freight and passengers charges on city and roundabout routes can be expressed as follows:

$$(R + r) [V_b + QP\gamma + \Pi\gamma] = R\alpha (V_o + QP\gamma + \Pi\gamma) + (R - r) \times [V_b + QP\gamma + \Pi\gamma], \quad (5)$$

where Π – the total passenger traffic capacity for a compared term in passengers; $\gamma = \frac{\beta' - 1}{1 - \frac{\delta'}{\beta}}$ – the expression which

considers the coefficient of an annual gain of transportation volume β and effectiveness ratio of capital investments in road construction δ .

Having solved the Equation (5), we'll obtain the formula for determining the radius of a by-pass, taking into account the freight and passenger traffic:

$$R = \frac{r \{2V_b + \gamma [QP + \Pi]\}}{\gamma [QP + \Pi] - \alpha V_o}. \quad (6)$$

Except the considered above model of roundabout motor roads, a simpler model of by-pass, which consists of two rectilinear sites heading out from an introduction motor road at an angle (Fig. 3) can be applied.

The indicated model of by-pass can be used in the settlements compact and drawn out in length settlements for which such scheme to the greatest degree answers the natural or designing conditions of urban development.

Let's consider a case when a highway crosses a city and on it, except transit, there is watched heavy urban road traffic. For the ascent of transit cars to city boundaries it is necessary to construct a roundabout motor road which should pass through any reference point D (a limit of existing or perspective building of a city or any other point which fixes a by-pass position). The total road and transport consumptions for the design period thus should be minimum.

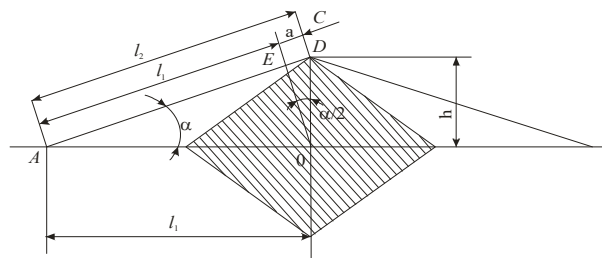


Fig. 3. The scheme concerning determination of the corner of unlocking a roundabout motor road

Solving of this task is reduced to determining the angle of unlocking the by-pass α from an introduction motor road. According to the scheme the corner size α is obtained by equality:

$$l_1 \left[\frac{V_b}{\sum QP} \right] = l_2 \left[\frac{V_o}{\sum QPF} \right], \quad (7)$$

where l_1 the length of the site of the introduction motor road placed between the point of unlocking of a by-pass and downtown area; l_2 – length of a roundabout motor road (to point D).

For corner determination α we obtain $l_2 = l_1 + a$, where $a = l_2 - l_1$. from triangles AOD and EOA (Fig. 3)

$$\frac{a}{l_1} = \sin \frac{\alpha}{2},$$

whence

$$a = l_1 \sin \frac{\alpha}{2}, \text{ and } 2a = 2l_1 \sin \frac{\alpha}{2},$$

$$\cos \alpha = \frac{l_1}{l_2}, \quad l_2 = \frac{l_1}{\cos \alpha}, \quad a = l_1 \left(\frac{1}{\cos \alpha} - 1 \right).$$

After substitution the Equation (6) will be as follows:

$$l_1 \left[\frac{V_B}{\sum QP} \right] = \left[l_1 + l_1 \left(\frac{1}{\cos \alpha} - 1 \right) \right] \times \left(\frac{V_o}{\sum QPF} \right), \quad (8)$$

whence

$$\cos \alpha = \frac{\left(\frac{V_o}{\sum QPF} \right)}{\left(\frac{V_B}{\sum QP} \right)}. \quad (9)$$

Knowing the corner, it is easy to determine the length of a roundabout motor road:

$$l_2 = \frac{h}{\sin \alpha}.$$

The length of a site of an introduction motor road between points A i O is determined by the formula:

$$l_1 = l_2 \cos \alpha.$$

The obtained relations by determination of radii of by-passes and the corner of unlocking roundabout motor roads form the basis for exact accommodation of a road network on the territories nearest to a city (Andreev 1977).

The justification of building roundabout motor roads in settlements drawn out in length

Designing of motor roads on territories of existing or perspective building of cities has feature that as a result of growth of city territory along motor roads they will be renovated in city streets with particular traffic conditions inherent for them and a city accomplishment. Therefore, at motor road selection on territories of perspective building of settlements it is necessary to aspire to such accommodation which would meet the requirements of planning a city street network at complete providing the best transport and operational parameters of carriages by road and traffic safety (Babkov 1993).

Accepting of the scheme of a road network in each case will be directed by miscellaneous conditions which reconstruct a historically created urban street network, production, geomorphological, ecological, hydrological and other conditions which influence forming a design highway network. Availability of such data gives the chance to provide in good time a direction of growth and the definitive form of city territory.

Meaning perspective development of a territory of settlements, it is reasonable to make classification of cities to signs of their future development. Establishing of laws of development and the future form of the city territory gives the chance to determine the limits of distribution of town-planning requirements of the main sites of motor roads (Babkov 1987), and receive this or that scheme of a road network.

An important question at road net designing on territories of perspective building of cities is the justification of building roundabout motor roads. Correctly designed and the constructed roundabout motor roads give the chance to direct motion of transit cars outside city limits, and partially collect the urban traffic. The classification of cities is presented in Table 2.

Transport communication between separate circumferential districts of the city on roundabout motor roads the overload of the central districts of the city transport give the chance to avoid and the same to improve vital conditions in a city. Significant advantage thus is the capability considerably to pick up speed motions of cars on roundabout motor roads in comparison with a speed in city streets.

Table 2. Classification of cities

Group of cities	Character of city development	Typical forms of moving (subgroup)
I	Cities free in the development	A. Unique compact city B. City agglomerations
II	Cities partially limited in the development	A. Unique compact city B. Cities drawn out in length
III	Cities very limited in development	A. unique compact city B. Unique compact city, drawn out in length

In activity the method ekologo – the power justification of determination of radius (distance) of roundabout motor roads which are designed round cities And group, according to the received classification in Table 2 is offered. This method is called by “a method of simultaneous access”. As the parametre for ekologo-energetichnogo justifications of radius of a roundabout motor road is used a ratio of times of jointing between the set points during motion of cars on roundabout motor roads and city streets. In activity the method of simultaneous access is used for ekologo – the power justification of versions of roundabout motor roads which are designed in the settlements which have been drawn out in a length (II and III groups).

Such motor roads in more simple case are shown by two parallel motor roads, which cover a city lengthwise and closed of the end parties cross-section sites.

The solution of a task from the justification of versions of roundabout motor roads round such cities is necessary for executing in two steps: separately for motor roads which are entered into a city from the longitudinal and cross-section parties.

At entering of a motor road from the end party of a city and in the presence of a dense network (Fig. 4) cross-section streets comfort of journey on a roundabout motor road will be ensured under conditions, if on journey from a point *A* (adjoining the main plot to the necessary automobile contiguity of the main site to a roundabout motor road) to point *D* (a point, which lies within city territory) on route *ABCD* (on a roundabout motor road) will spend less time, than on route *AED* on introduction road that is:

$$\frac{R+a}{V_k} + \frac{R-b}{V_{cep}} \leq \frac{a+b}{V_{cep}}, \quad (10)$$

where *R* – the distance from an introduction motor road to a by-pass site, m; *a* – the distance from a cross-section site of a roundabout motor road to a point *E*, m; *b* – the distance from an introduction motor road to point *D*, m.

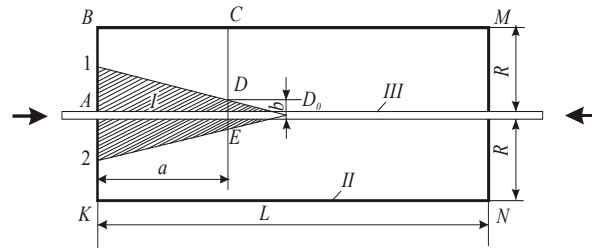


Fig. 4. A configuration of city territory which is in a zone of transport effect of an introduction motor road: And – a line of simultaneous access; II – a roundabout motor road; III – a longitudinal introduction motor road

At the solution of an inequality (10) we have a capability to find a position of a line of simultaneous access for cars which are directed to a city on roundabout motor roads.

After transformation of an inequality (10) we receive:

$$2bV_k \geq RV_{cep} + aV_{cep} + RV_k - aV_k,$$

whence

$$b = \left(\frac{R+a}{V_k} \right) + \frac{V_{cep}}{V_k} \leq \frac{R-a}{2}. \quad (10)$$

In limiting cases at $a = 0$,

$$b \geq \frac{R}{2} \left(\frac{V_{cep}}{V_k} + 1 \right), \quad (11)$$

At $b = 0$,

$$a = \frac{R}{\left(1 - \frac{V_{cep}}{V_k} \right)} \left(\frac{V_{cep}}{V_k} + 1 \right). \quad (12)$$

Function $b = f(a)$, which is expressed by equality (11), is shown graphically in Figure 3 for cars which drive to a city on one of introduction motor roads.

This scheme gives the chance present obviously distribution of city territory to separate zones which enter in sphere of servicing of this or that motor road. The city territory, ооконтурена lines of simultaneous access (hatched), can be maintained only longitudinal introduction road, remaining territory – a roundabout motor road.

It is necessary to mean inconstancy of this zone which all time will “be browsed in” after building of the end parties of a city and a distance of cross-section sites of a roundabout motor road. Thus, the zone which is maintained by the roundabout motor road, all time will be increased.

When building from any end party is impossible, the zone of servicing of city territory a roundabout motor road in this area will be a constant. It gives the chance to place in it miscellaneous administrative and housing houses that behind the character do not attract a considerable quantity of cars.

At simultaneous action of two introduction motor roads disposed from the end parties, overlapping similar, but differently oriented schedules, gives the chance to outline in the city territory some zones of transport effect (Fig. 5).

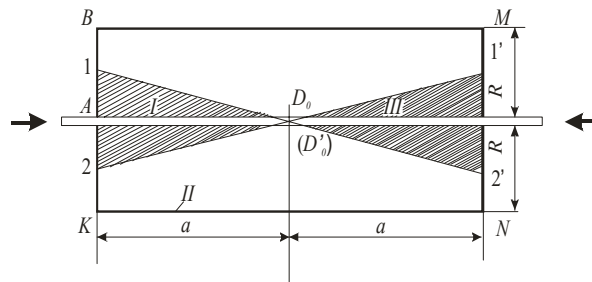


Fig. 5. Accommodation of parts of city territory which enter zone of transport effect of two introduction motor roads at a length of a city, equal $2a$

Drawing 4 shows increase in sphere of servicing of territory roundabout motor roads at the further growth of a city on a length. If the city length exceeds the size $2a$ then the territory between points D_0 And D'_0 On all breadth of a city will be maintained completely by a roundabout motor road.

For criterion of efficiency of building of roundabout motor roads around the cities, which have been drawn out in a length, it is possible to take the areas of city territories which are maintained by separately roundabout and introduction motor roads.

In the presence of introduction highways which adjoin a city in cross direction (Fig. 6), condition of simultaneous access at journey of cars on introduction motor road $BCDE$ and on roundabout $BLKOE$ it is possible to record in the form of the equation:

$$\frac{2A - a + 2R}{V_k} + \frac{R - b}{V_{cep}} = \frac{R + b + a}{V_{cep}}, \quad (13)$$

where A – the distance from an introduction motor road to a cross-section site of a roundabout motor road; R – the distance from a longitudinal site of a roundabout motor road to a longitudinal introduction motor road; a and b – coordinates of a point which lies on a line of simultaneous access.

Solving Equation (13), it is afflicted formulas for a position fixing of points, which lie on a line of simultaneous access of cars.

The distance b is determined according to the following formula:

$$b = (A + R) \frac{V_{cep}}{V_k} - \frac{a}{2} \left(1 + \frac{V_{cep}}{V_k} \right). \quad (14)$$

In the presence of introduction highways which adjoin a city in cross direction is shown in Figure 6.

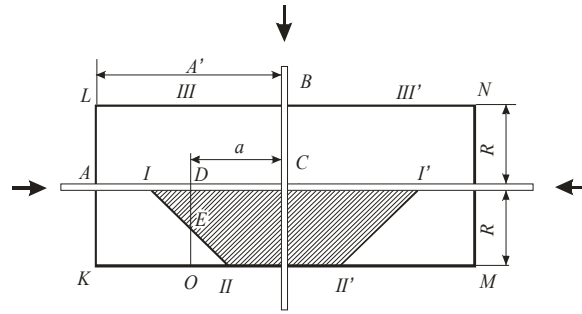


Fig. 6. A configuration of city territory which is in a zone of effect of a cross-section introduction motor road: I – an introduction motor road; II – a roundabout motor road; III – a cross-section introduction motor road

In limiting cases, at $b = 0$

$$a_{b=0} = \frac{2(A+R)\frac{V_{cep}}{V_k}}{1 + \frac{V_{cep}}{V_k}}. \quad (15)$$

At $b = R$

$$R = (A+R)\frac{V_{cep}}{V_k} - \frac{a}{2}\left(1 + \frac{V_{cep}}{V_k}\right),$$

$$a_{b=R} = \frac{2\left[(A+R)\frac{V_{cep}}{V_k} - R\right]}{1 + \frac{V_{cep}}{V_k}}. \quad (16)$$

At $a = 0$ and $b = R$ from the formula (14):

$$R = (A+R)\frac{V_{cep}}{V_k},$$

where

$$A = R\left(1 - \frac{V_{cep}}{V_k}\right)\frac{V_k}{V_{cep}}. \quad (17)$$

Hence, at such arrangement of cross-section introduction motor roads from an end site of a roundabout motor road journey is comfortable as through a city, and around. Under condition $A > R\left(1 - \frac{V_{cep}}{V_k}\right)\frac{V_k}{V_{cep}}$ vehicle trips to the opposite part of the city on the roundabout motorway is not comfortable.

Apparently, from Figure 6, in the presence of cross-section introduction motor roads only on the one hand cities the most part of city territory (not hatched) which is maintained by a roundabout motor road, especially city zones which are disposed from contiguity of an introduction motor road.

Thus, it is possible to mark that roundabout motor roads round the cities that have been drawn out in a length, can inject completely transit cars for city boundaries. Round the cities which have been drawn out in a length, it is possible to consider building of roundabout motor roads as the most reasonable at accommodation of introduction motor roads along a city. Such roundabout motor roads can undertake on all transit and a part of a city road transport, which is directed to opposite, districts of the city. If cross-section introduction motor roads adjoin from two parties of a city the zone of city territory, which is maintained by a roundabout motor road, considerably is moderated and takes place only in end parts of city territory. At simultaneous action of several cross-section and longitudinal introduction motor roads this zone is moderated even more (Fig. 7).

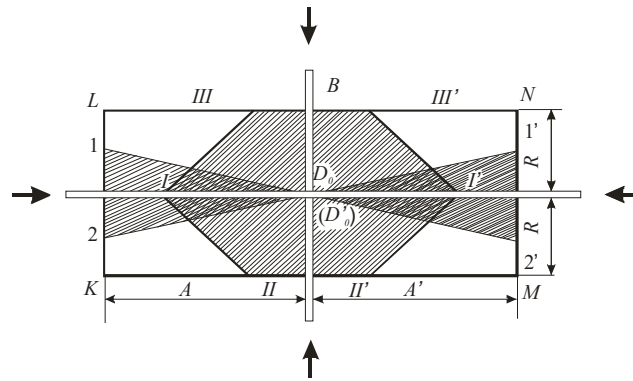


Fig. 7. Overlapping of parts of city territory which are in zones of transport effect of longitudinal and cross-section introduction motor roads

There is a big advantage of roundabout motor roads in settlements, which have been drawn out in length and in the presence of the cross-section introduction motor roads disposed only on one side of a city. In this case, the part of city territory, which is located on one side of cross-section introduction motor roads, is completely maintained by a roundabout motor road.

Conclusions

In the given work there were determined some versions of space arrangement of motor roads. Determinations of an option that meets the ecological and economic requirements to a great extent is a complex problem, as each of them has a number of positive and negative qualities.

The optimum version is selected according to an aggregate of technical, economic and ecological characteristics. Direct comparison of options according to the length of a road, the area and terrain composition which will be used for building by-passes round settlements does not yet give enough reason for ecology-economic selection, though it influences it in a significant measure. For this purpose, it is necessary to consider the entire complex of criteria.

The maximum usage of ring bypasses for city transportations is possible under condition of close accommodation of these bypasses from city buildings.

The justified in the work dependences for determining the radii of ring bypasses and the refraction angle of roundabout motor roads form the basis for perspective accommodation of a road network on the territories nearest to a city.

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