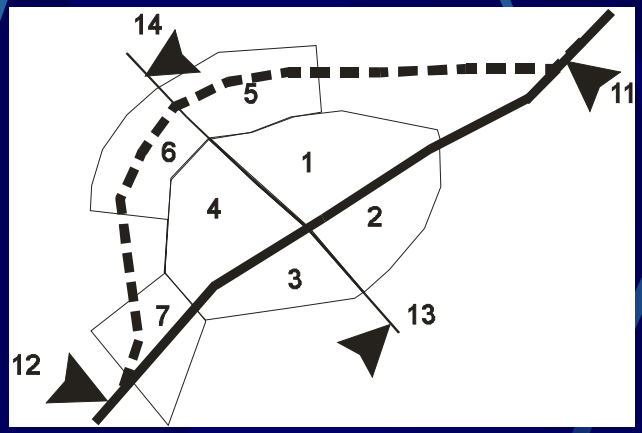
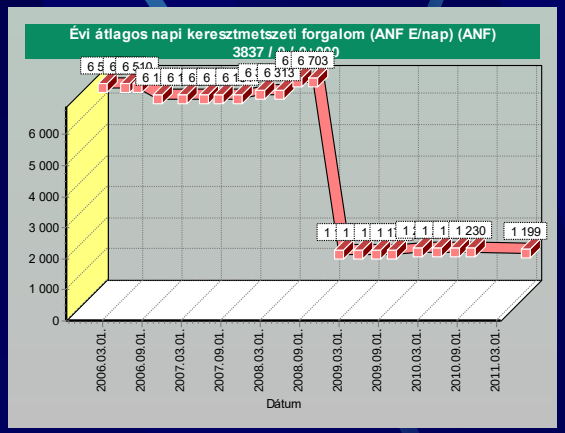
Bypass Roads, Urban Sections





Urban Transport 7.
András Gulyás PhD habil
associate professor

Content

- Functions of urban roads
- Traffic planning of urban roads
- Bypass roads and urban sections
- Traffic planning of bypass roads
- Design solutions of urban roads

Functions of urban roads

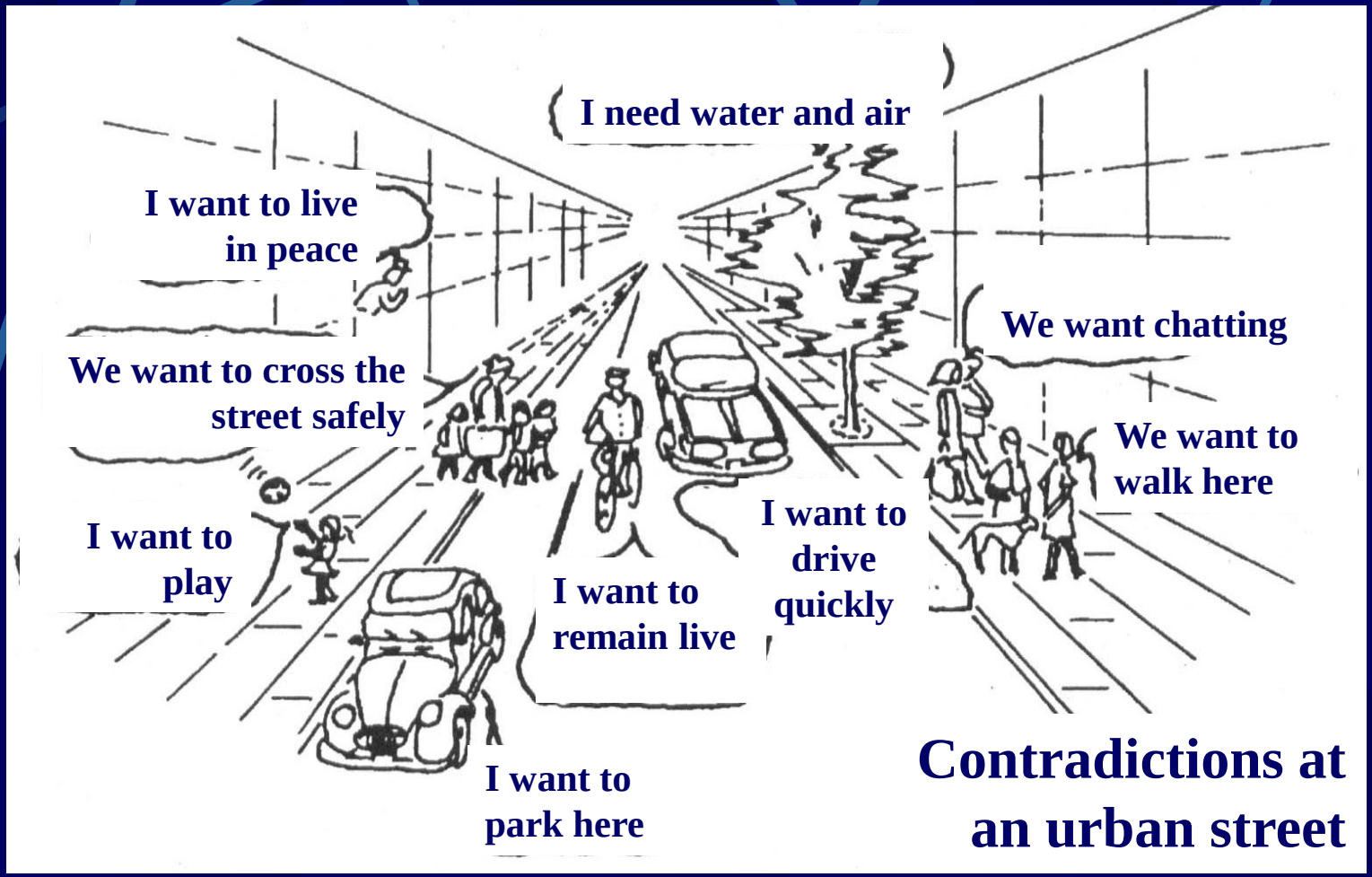
An urban road requires a complex approach.

Besides the traffic function there are other urban functions as well like staying.

Design of an urban roads must be performed from fence or wall to another fence or wall.

The operator of an urban road can be a national or a municipal organisation. National road sections going through settlements have both functions: national or regional and local.

Functions of urban roads



Contradictions at an urban street

Functions of urban roads

Travelling people and the road are in interaction depending on the place and shape of the road.

Human perception is based on schemes. Human brain classifies the world and its phenomena into categories.

The behaviour of a road user will be determined by expectations based on schemes and categories, meaning the general appearance of the road, its surroundings and its traffic situation.

Functions of urban roads

Formation of a road is good when the road user may get all necessary and correct information concerning the category of the road in order to choose a proper behaviour (*self explaining road*).

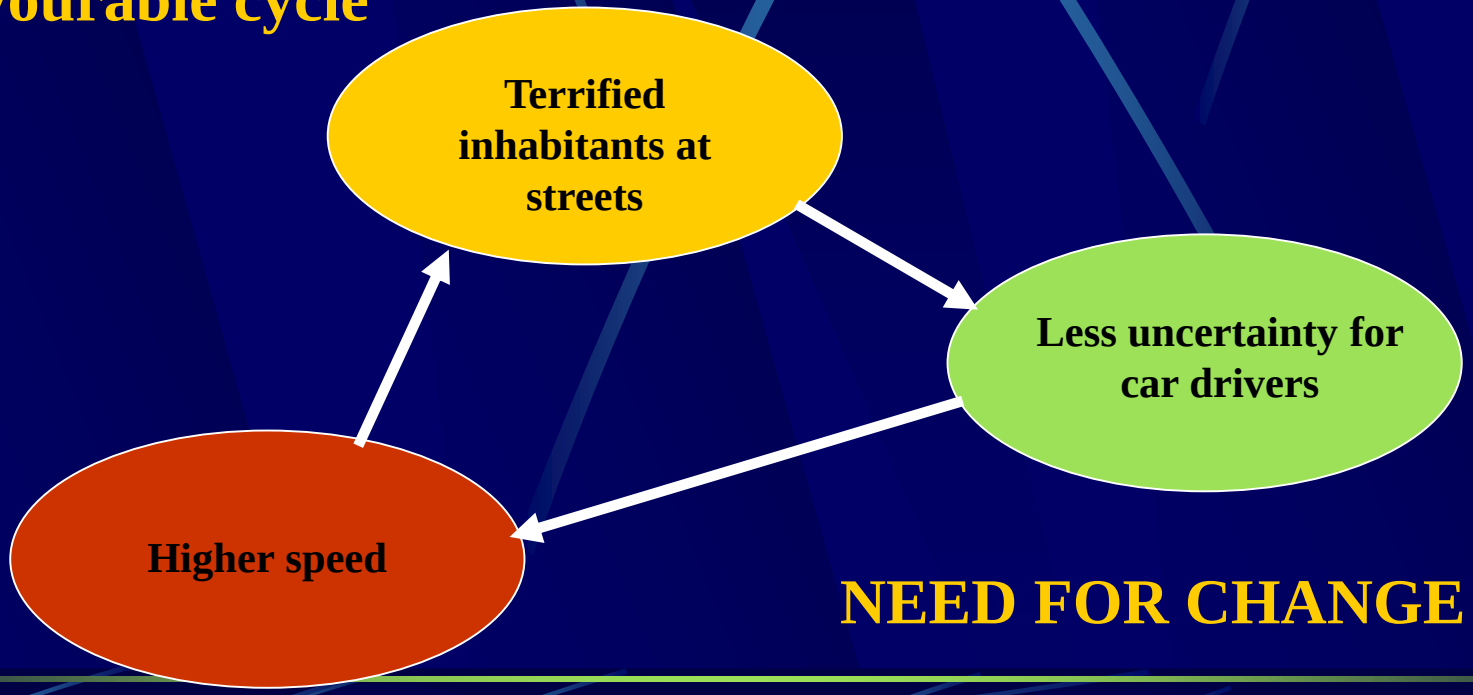
Road traffic safety is influenced by high level standardisation of design from the road side and adequate driving experience from the human side.

The less are the road categories the better is their recognition.

Functions of urban roads

Traffic calming is possible without physical means on a mental and socio-cultural basis.

Unfavourable cycle



NEED FOR CHANGE !

Functions of urban roads

Predictable, calculable environment gives a false sense of safety for car drivers.

When there is a real possibility for something unexpected, attention of drivers is increased and their speed is decreased.

In the formation of urban roads the perceived risk should be larger or at least equal compared to the factual risk.

Drivers must sense that they are driving in a city.

Functions of urban roads

Fitting of the road traffic to urban functions:

- **settlement entry gates at the beginning of an urban section provide a warning concerning the changing situation moreover these gates slow down rural traffic speed,**
- **pedestrian crossings on the urban section with isles,**
- **roadside vegetation, tidied public areas,**
- **traffic engineering solutions for raising attention (light reflecting prisms, yellow caution light signal, etc.),**
- **roundabout type junctions at entry points if possible.**

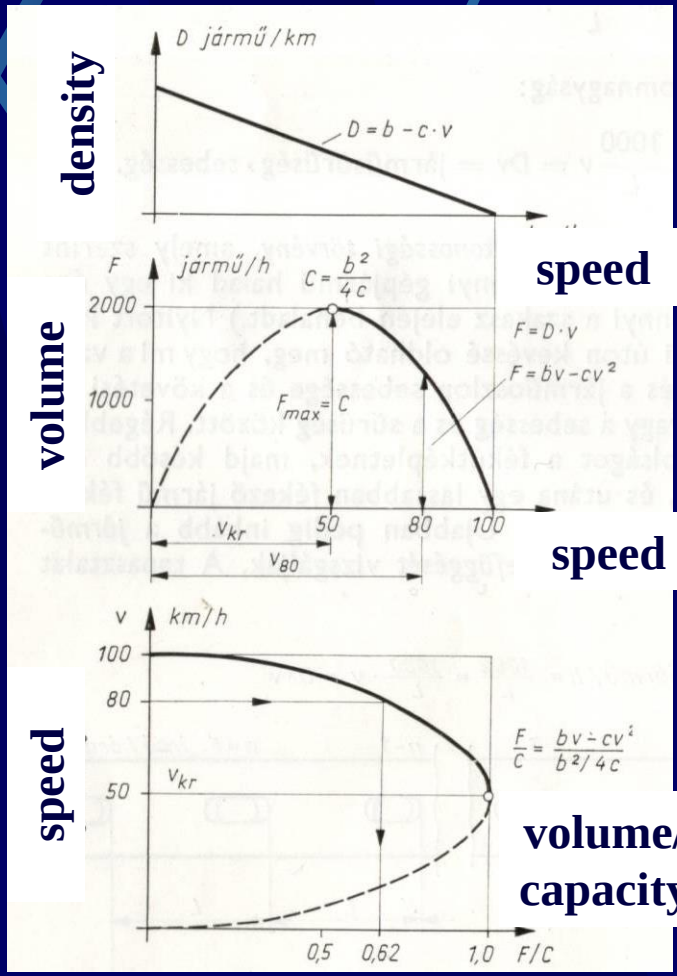
Traffic planning of urban roads

Traffic volume or traffic flow of a cross section is in linear proportion with traffic density and speed

F (v/h) = D (v/km) * v (km/h)

This is the fundamental relationship and diagram

Explains the congestion (traffic jam) phenomena



Traffic planning of urban roads

The aim of the traffic based design at a cross section is to ensure that the peak hour traffic volume (traffic flow) is less or equal to the allowable traffic volume $F_{all} \geq PHT$.

The allowable traffic volumes are prescribed in standards or technical guidelines.

In the Hungarian technical guidelines there are four categories of urban roads with appropriate allowable traffic volumes.

Traffic planning of urban roads

Network function „a”: main road that determines settlement structure, mainly connection function with through traffic, less important are distribution or service functions.

Network function „b”: main road that partially determines settlement structure, distribution function is present besides connection function.

Network function „c”: element of local settlement structure, proportional distribution and service functions, with constrained connection function.

Network function „d”: road for service function, the distribution function is controlled, no connection function.

Traffic planning of urban roads

Capacity of urban roads (Hungarian standard)

Network function	Traffic volume pcu/h	
Level of service	adequate	allowable
2*2 or more lanes „a” function: 1 lane	1200	1600
2*2 lanes „b” function: 1 lane	900	1300
2 lanes „a” function: 2 lanes	1500	2000
2 lanes „b” function: 2 lanes	1000	1200
2 lanes „c” function: 2 lanes	800	1000

Traffic planning of urban roads

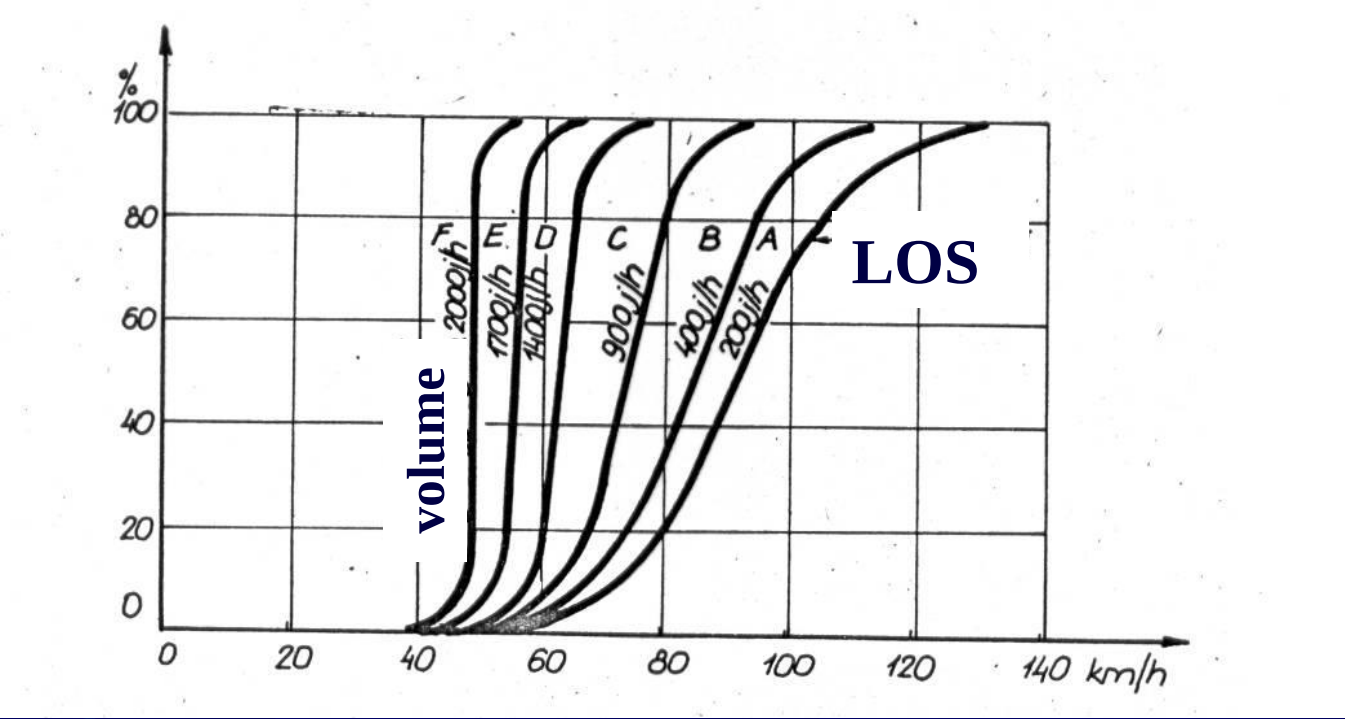
Capacity volumes are given for one lane in case of 2 or more lanes per direction and for two lanes together in case of 2 lane roads.

Capacity reduction factors must be considered for: distance of junctions, parking lane, bus lane, access to properties, bus stop, pedestrian crossing, pavement width etc.

Value of a reduction factor is usually 0,8 - 0,9.

Traffic planning of urban roads

The USA Highway Capacity Manual determines 6 different levels of service (LOS) with 6 different speed distribution curves.



Traffic planning of urban roads

„A” level of service - free flow

Traffic flows at or above the posted speed limit and motorists have complete mobility between lanes. Generally occurs late at night in urban areas and frequently in rural areas.

„B” level of service - reasonably free flow

Free speeds are still maintained, manoeuvrability within the traffic stream is slightly restricted.

„C” level of service - stable flow, at or near free flow

Ability to manoeuvre through lanes is noticeably restricted and lane changes require more driver awareness. Target for some urban and most rural roads.

Traffic planning of urban roads

„D” level of service - approaching unstable flow

Speeds slightly decrease as traffic volume slightly increase. It is a common goal for urban streets during peak hours.

„E” level of service - unstable flow, operating at capacity

Flow becomes irregular and speed varies rapidly because there are virtually no usable gaps to manoeuvre in the traffic stream and speeds rarely reach the posted limit. This is a common standard in larger urban areas, where some roadway congestion is inevitable

„F” level of service - forced or breakdown flow

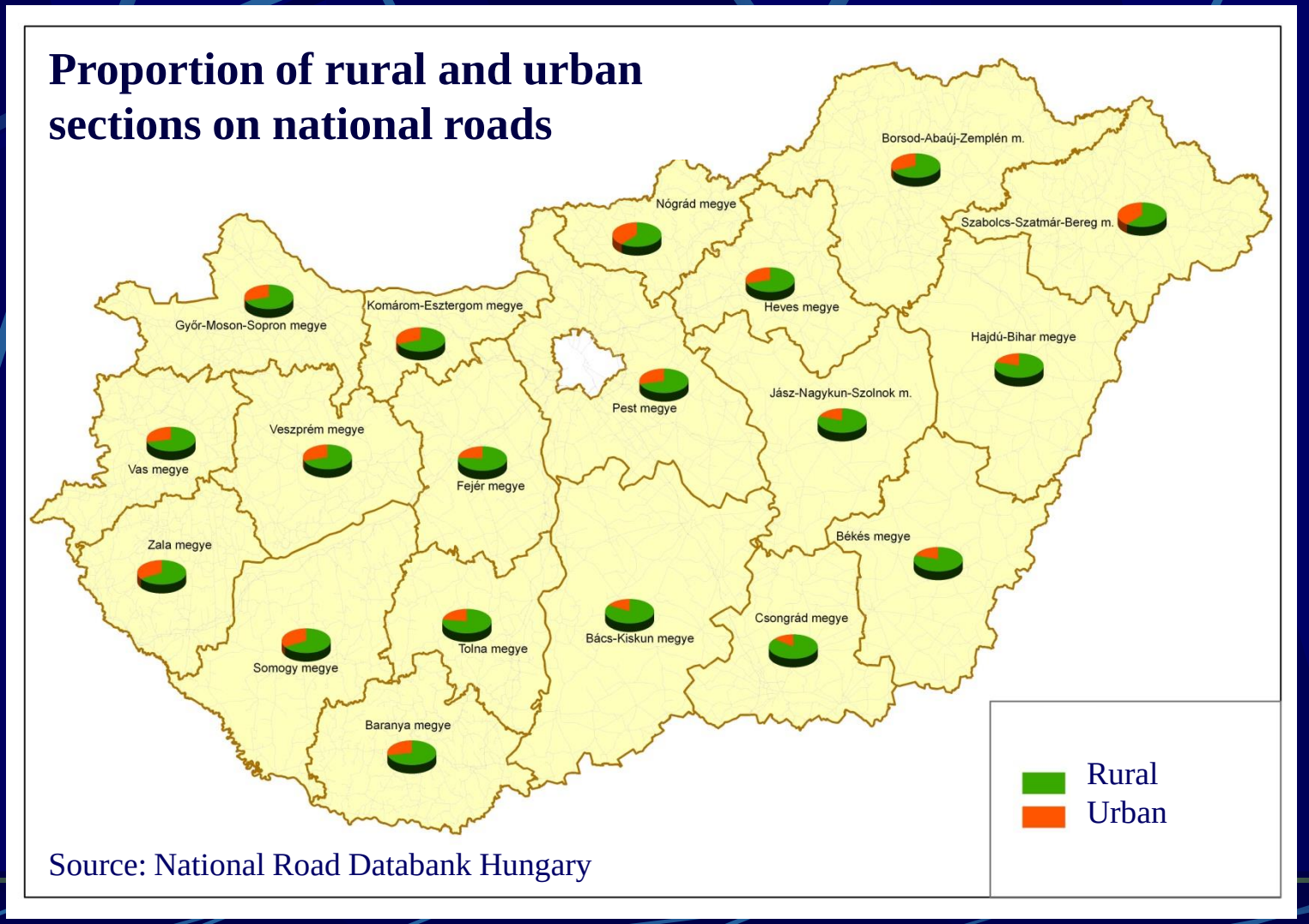
Vehicles move in a lock with the vehicle in front of it, with frequent slowing required. A constant traffic jam occurs.

Traffic planning of urban roads

The fifth edition of the Highway Capacity Manual, HCM) has been published in the USA in 2011.

In case of urban roads there is an integrated approach in the HCM handling together motorised traffic, public transport and non-motorised modes (cycling and walking).

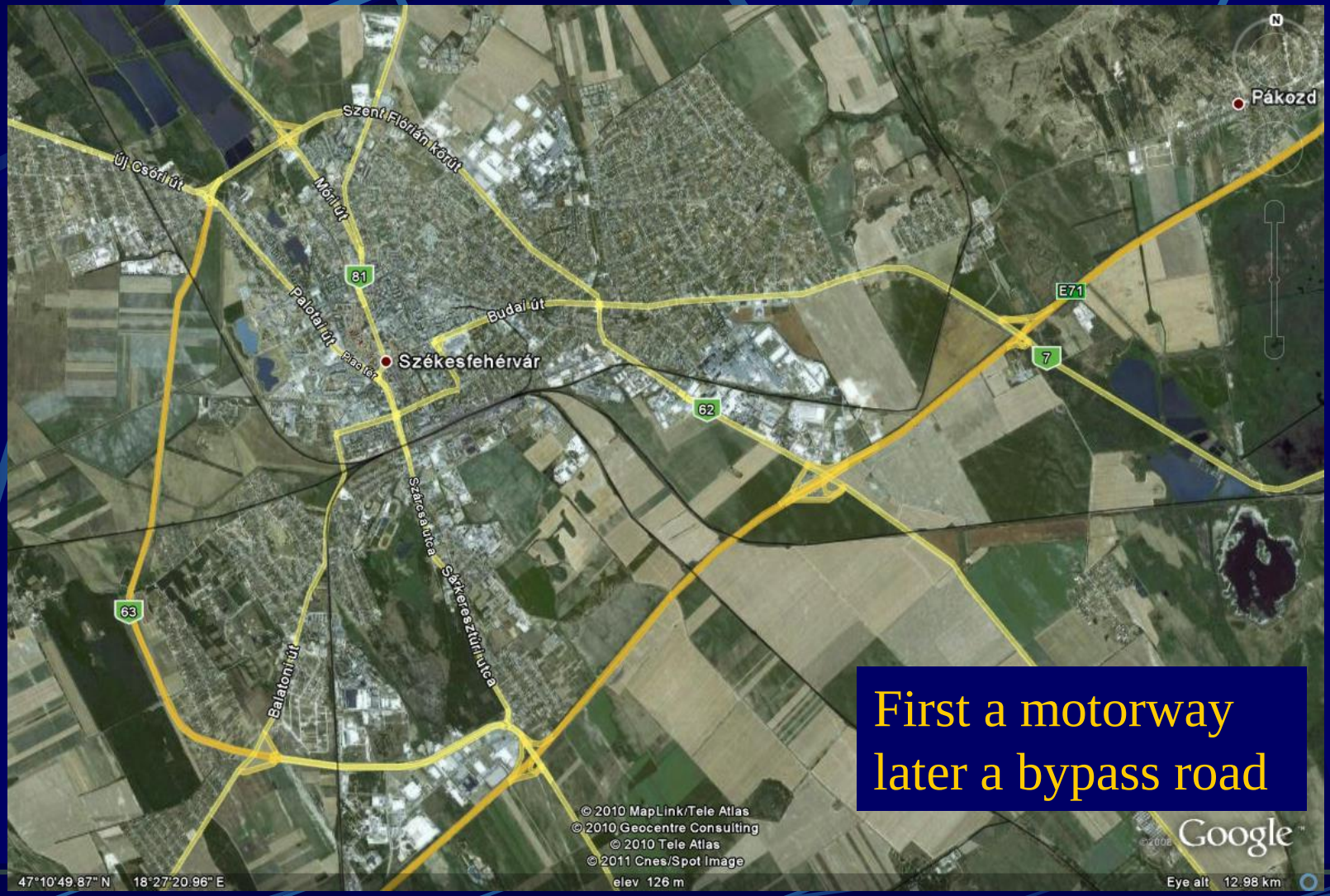
Bypass roads and urban sections



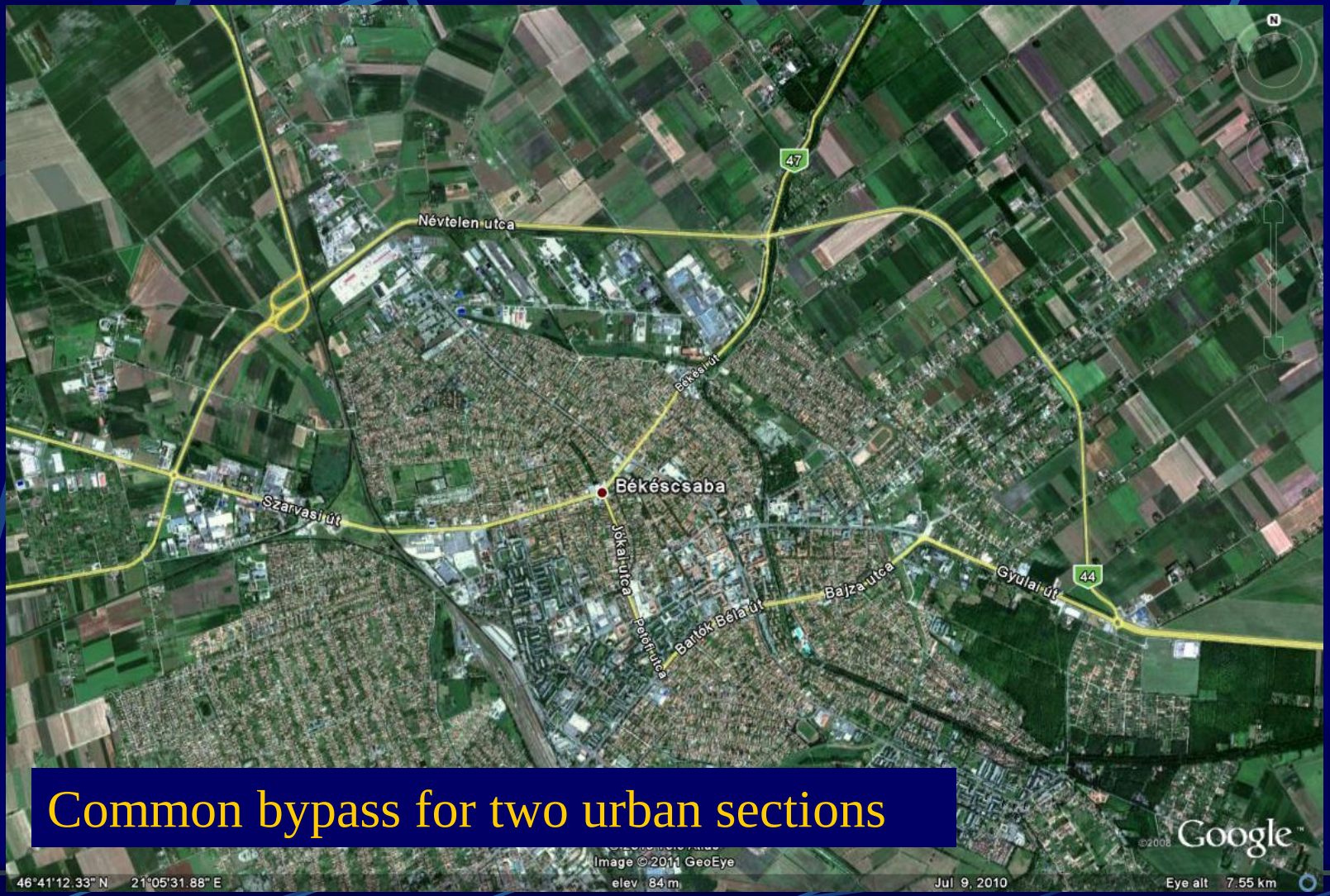
Bypass roads and urban sections

First a bypass road
later a motorway

Bypass roads and urban sections

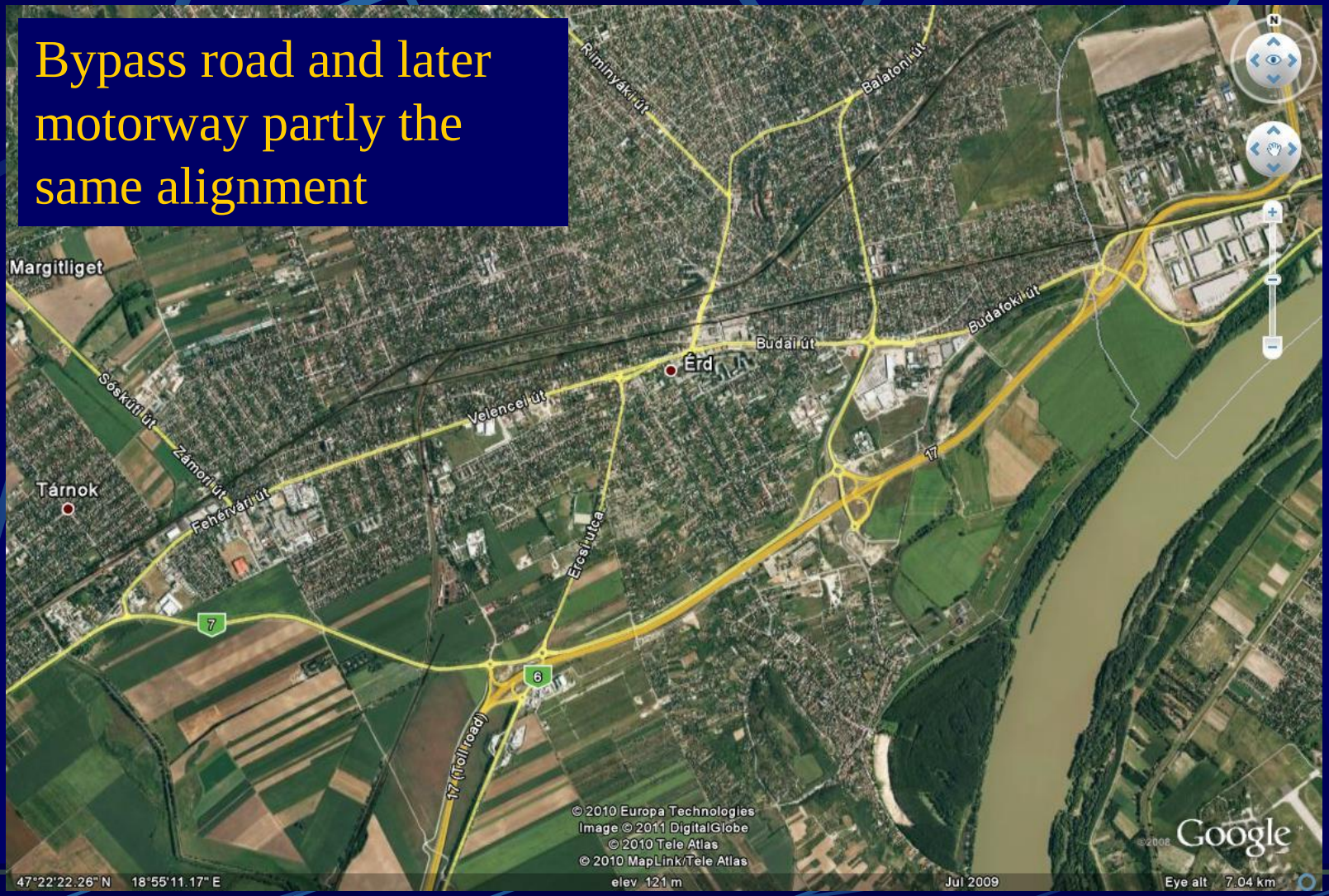


Bypass roads and urban sections

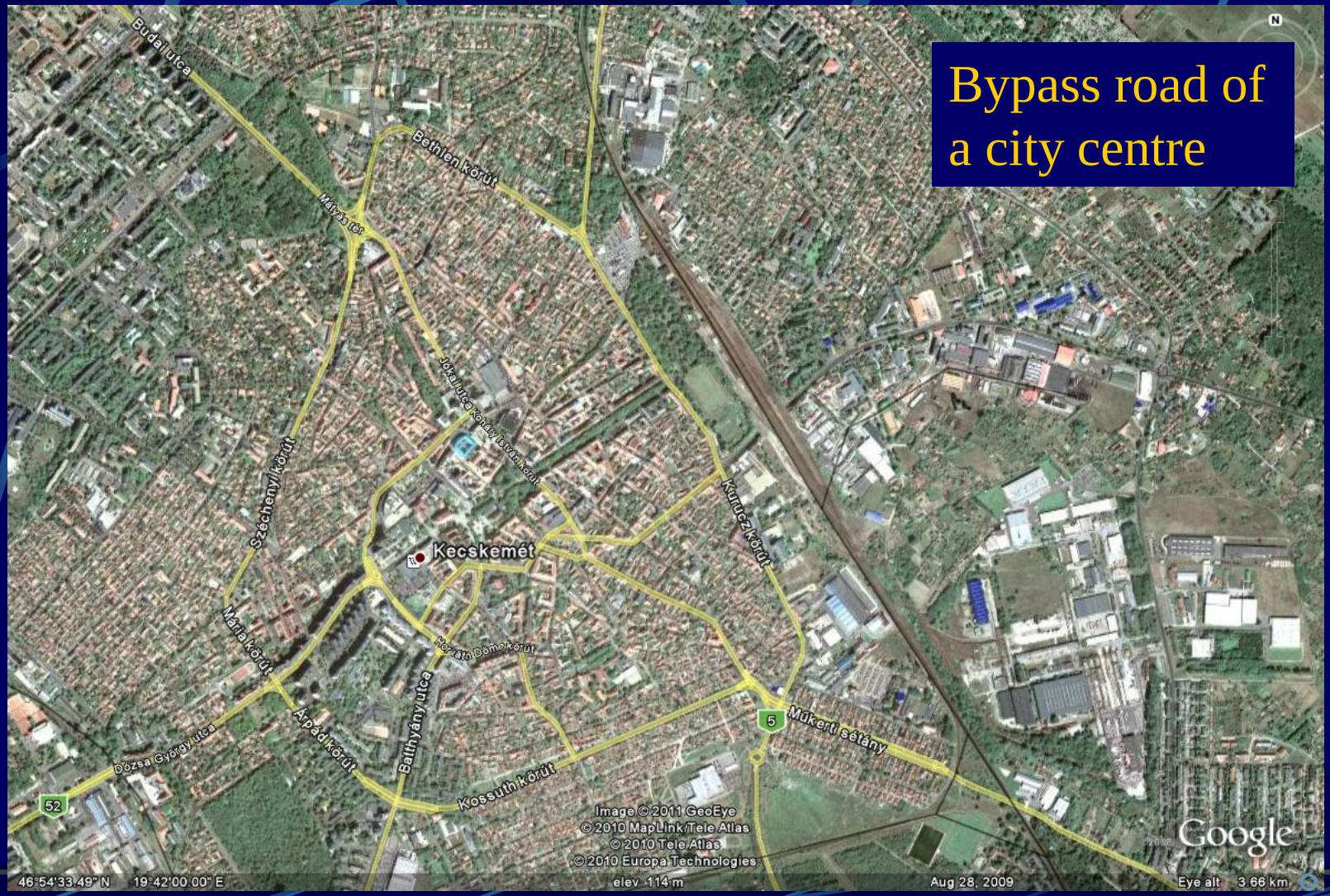


Common bypass for two urban sections

Bypass roads and urban sections



Bypass roads and urban sections



Bypass roads and urban sections

Bypass roads and urban sections

In Kecskemét the urban section of main road „5” has been replaced by a ring road system of 2 rings.

The inner ring is a one-way road to be „get used to”.

The through traffic has been lead off by the motorway.

The original section in the city centre was closed for a public utility reconstruction and never opened for road traffic.

Source: Google Earth

Bypass roads and urban sections

High-speed type bypass road

Bypass roads and urban sections

Kaposvár city centre – a pedestrian street at the former main road

Main road „61” has been replaced in two phases:

first a new urban section with 4 lanes was constructed,

later a real bypass road outside the built-in area.

The original urban section became a pedestrian street, the first phase road became an urban main road.

Source: Google Earth

Bypass roads and urban sections

Main road at the verge of the city centre

Bypass roads and urban sections

Bypass roads and urban sections

Kaposvár pedestrian street – former main road

Source: Google Earth

Bypass roads and urban sections

A real bypass road may take over 30 - 85 % of the traffic volume of the former urban section depending on city size and other characteristics.

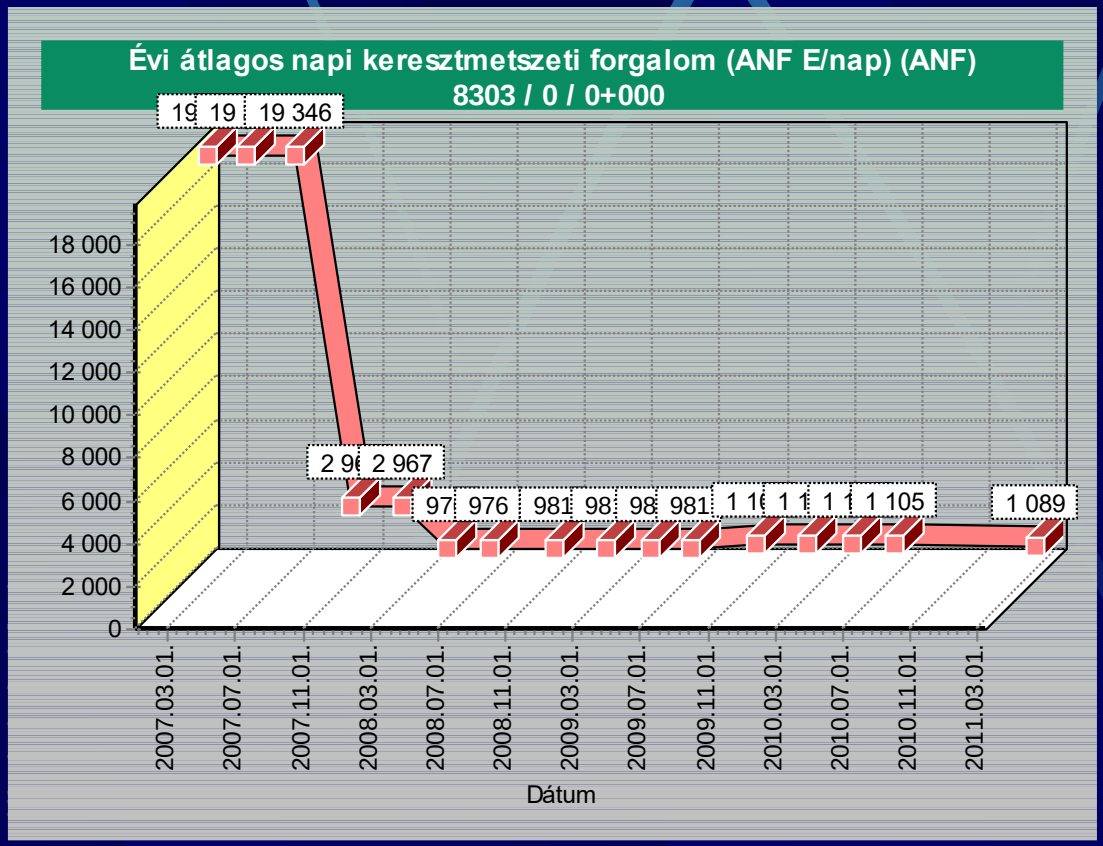
In bigger cities the inner and origin-destination traffic gives bigger volumes on the urban section.

The smaller the settlement the bigger the proportion of traffic volume on the bypass road.

A bypass road of a higher network function takes away more traffic from the urban section in the city area.

Bypass roads and urban sections

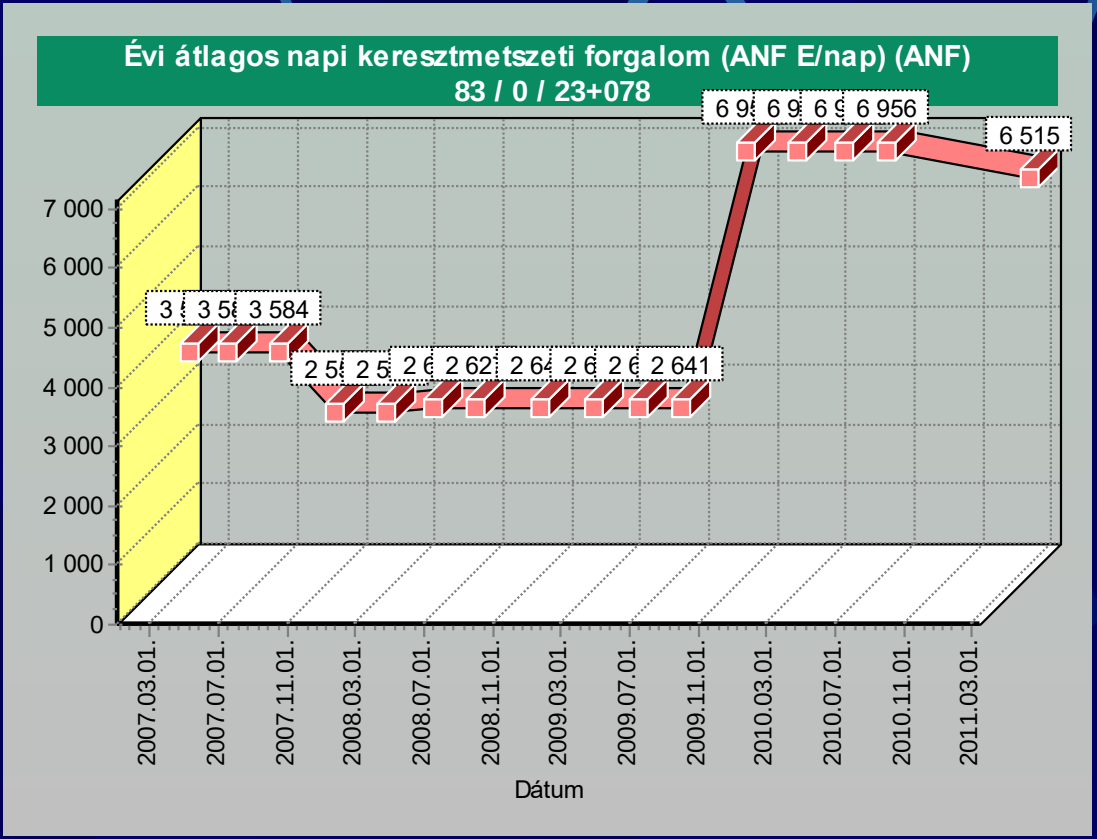
Pápa traffic volume change on the urban section



Source: National Road Databank Hungary

Bypass roads and urban sections

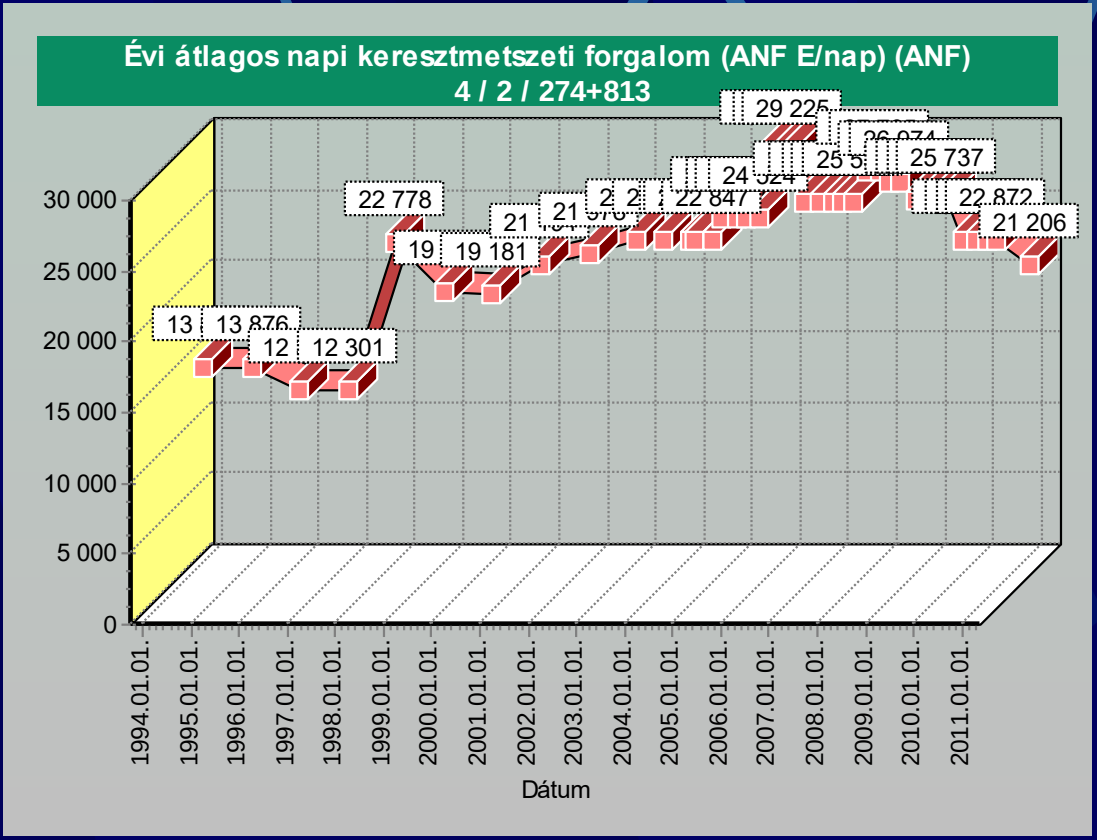
Pápa traffic volume change on the bypass road – 2 phases



Source: National Road Databank Hungary

Bypass roads and urban sections

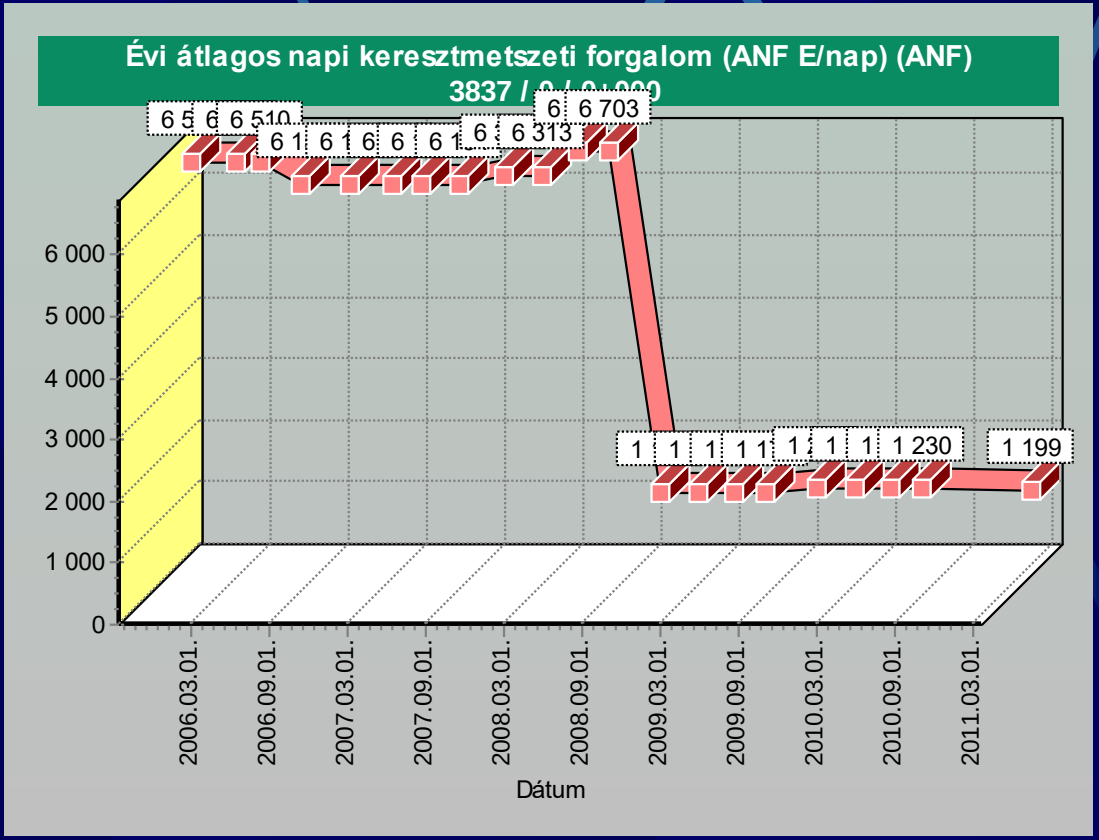
Nyíregyháza traffic volume change on the urban section – multi-phased construction



Source: National Road Databank Hungary

Bypass roads and urban sections

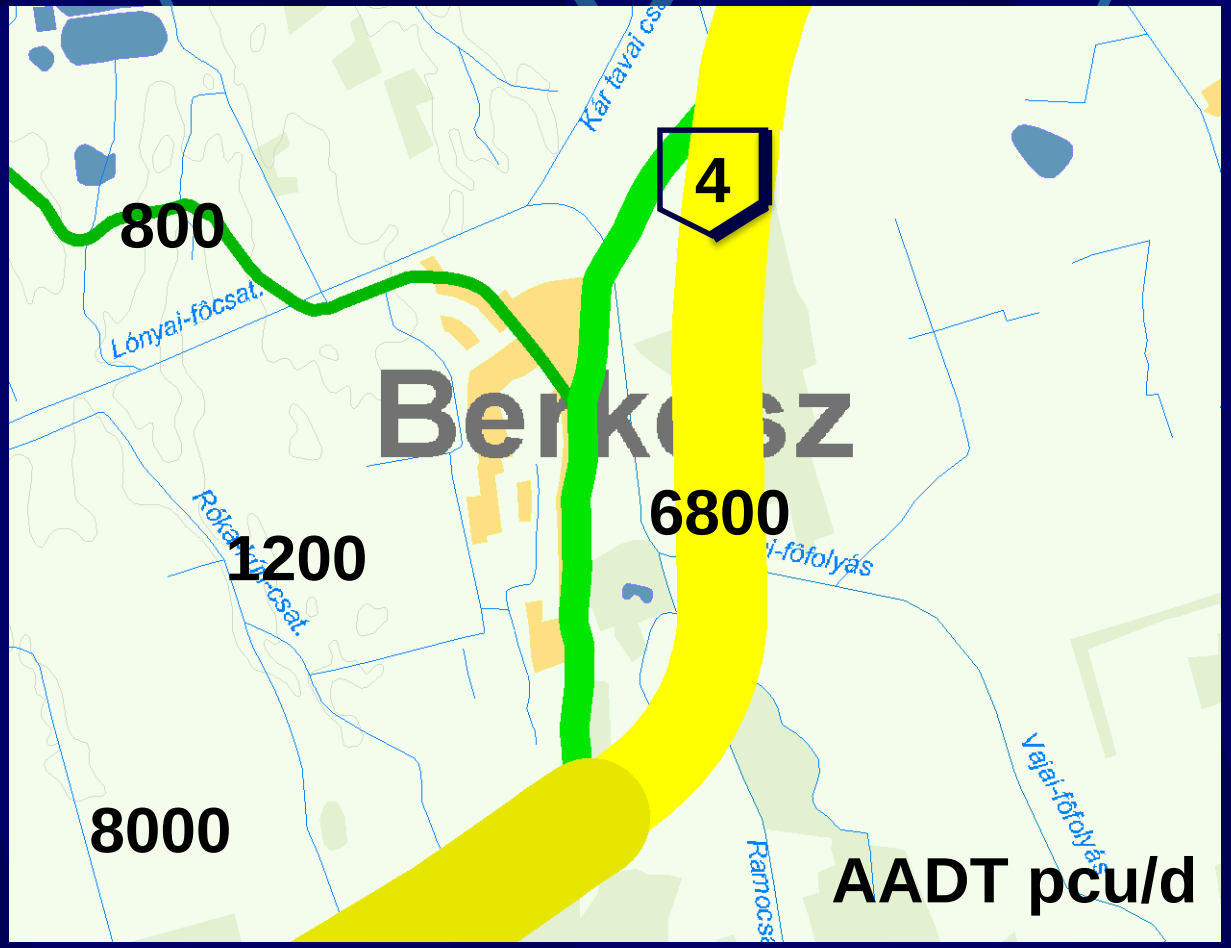
Berkesz traffic volume change on the urban section – former main road „4”



Source: National Road Databank Hungary

Bypass roads and urban sections

Berkesz traffic volumes



Source: National Road Databank Hungary

Traffic planning of bypass roads

In case of smaller settlements the traffic planning of the bypass road can be performed by a simplified method, applying projective traffic estimation.

The simplified method is suitable when the planned development will not cause big changes in the inner traffic of the settlement.

In case of high volume through traffic this is the situation, the inner traffic is not significant, usually less than 35 % of the former urban section with the through traffic.

Traffic planning of bypass roads

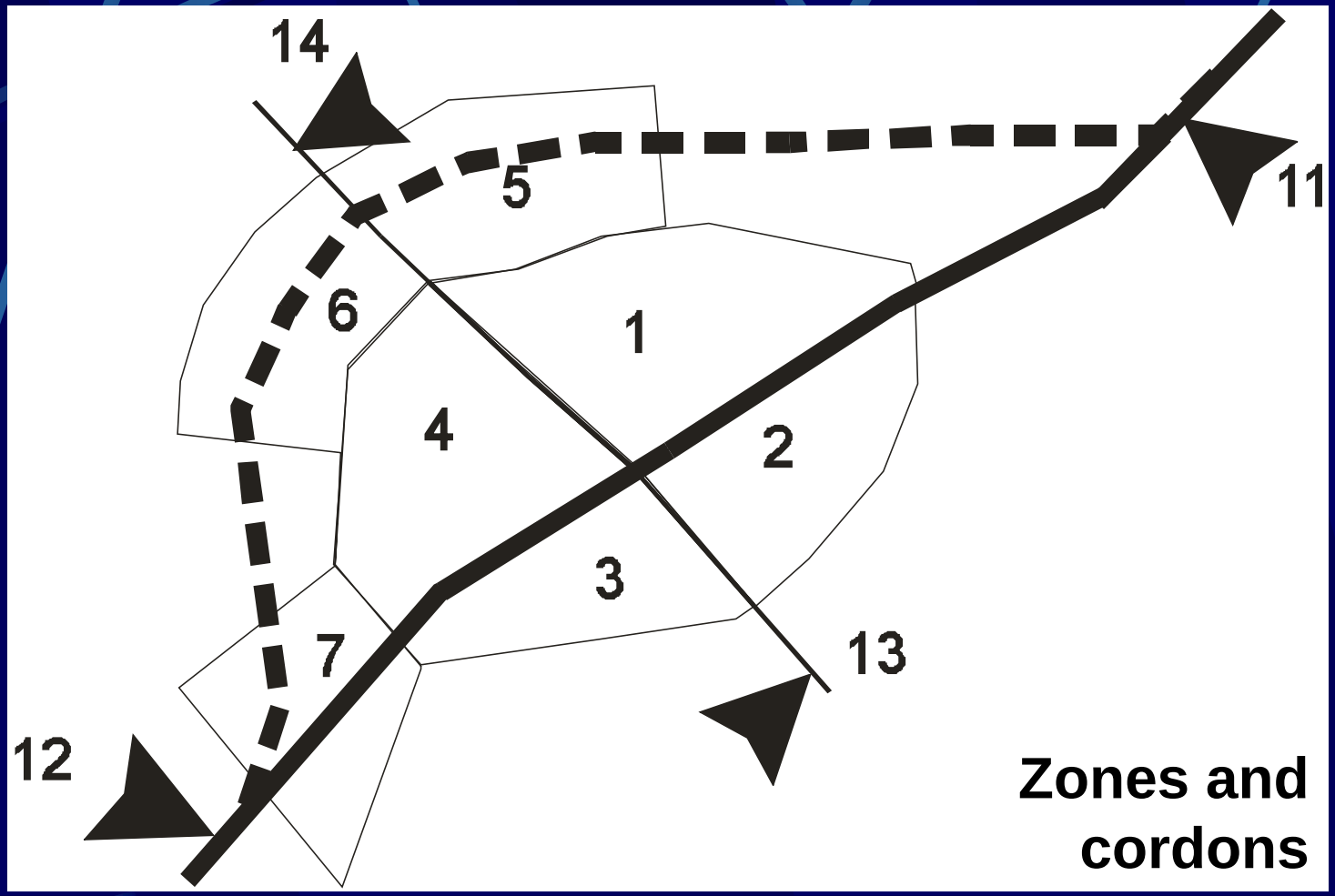
Main steps of the simplified method:

1. **The settlement is divided into zones, practically a few zones, eight to ten. The zones cover the current inhabited area of the settlement (in the example: 1 - 4) as well as the area of the planned bypass road (in the example: 5 - 7). These new zones along the bypass road are necessary if there will be significant new investments along the bypass road with traffic generation and attraction.**

Traffic planning of bypass roads

2. Added to the zones there are the so called cordon points outside the joining points of the former main road and its bypass road. These cordons represent the through traffic (in the example: 11 - 14).
3. The road network model is the next step that usually consists of less than 50 sections. Travel speeds and travel times on the existing sections are measured by simple methods.

Traffic planning of bypass roads



Traffic planning of bypass roads

4. For the calculation of the origin-destination matrix an origin-destination (O-D) type traffic survey must be performed. The method used can be the „licence plate numbers” or the „stop and ask” method, both in 12 hours (6 - 18 usually) at cordon points. There is a need for cross sectional traffic volume counts at the cordons because the O-D survey is a sample and the basic population size (the total cross section traffic volume) must be known.

Traffic planning of bypass roads

5. The daily O-D matrix from the 12 hours O-D matrix is calculated by multiplying the matrix elements with daily factors that can be obtained from the national traffic count publications or any other relevant source.
6. The assignment of the current traffic to the current network using the O-D matrix can be performed by any suitable method using either a software package or even a manual method (in case of smaller areas with less zones).

Traffic planning of bypass roads

Traffic matrix	1 - 4	5 - 7	11 - 14	sum
1 - 4	Inner traffic	inner developed	origin-destination	generation
5 - 7	inner developed	Inner developed	O-D developed	generation
11 - 14	origin-destination	O-D developed	through traffic	generation
sum	attraction	attraction	attraction	total traffic

Traffic planning of bypass roads

7. Traffic volumes in the future are calculated by the growth factor method, where the growth factors to be applied can be chosen from the national traffic count publications or any other relevant source. Growth factors for the through traffic, the O-D traffic and the inner traffic may differ from each other.
8. The assignment of the future traffic matrix elements to the planned future network is similar to the current case.

Traffic planning of bypass roads

9. The surplus effect of any significant new investments along the bypass road with traffic generation and attraction can be calculated by a special method taking into account the characteristics of the new investment (i.e. shop area) and its specific traffic generation and attraction factors.

Design solutions of urban roads

Design details of urban sections of former national roads after the construction of a bypass road:

- **joining the bypass road as a minor road,**
- **settlement gate emphasising the functional change,**
- **reduction of the number of former traffic lanes,**
- **decrease of the width of the remaining traffic lanes,**
- **application of traffic calming measures,**
- **alignment at the verge of the city centre,**
- **roundabouts or signalised junctions,**
- **roadside parking possibilities,**
- **bicycle lanes.**

Design solutions of urban roads

In the junction of the bypass road and the former main road the priority must be given to the bypass road for the through traffic going straight.

For the destination traffic directing to the settlement there must be an appropriate sign system, in case of a larger settlement denoting the nearby parts of the settlement.

The operator of the former national urban section will be usually the municipality.

Design solutions of urban roads

Design solutions of urban roads

Source: Google Earth

Design solutions of urban roads

The settlement gate emphasises the changing of traffic circumstances for drivers.

Usual design for a settlement gate is a lane drawing with a decreased lane width (i.e. 3,25 m).

Important is the safe driveability and the ensuring of a practical decrease of the speed.

If a junction is at the border of the settlement, the recommended type is the roundabout that forms at the same time a settlement gate.

Design solutions of urban roads

Settlement gate at the entry

Source: Google Earth

Design solutions of urban roads

Lane reduction or road diet (*Rückbau* in German) – reduction of the number traffic lanes on a former high-trafficked urban section after the construction of a bypass road.

Cross section of the road is adapted to remaining traffic volume (i.e. 2 traffic lanes instead of 4).

Implementing of roadside parking, central dividing lane, vegetation, bicycle lane etc. will be possible.

Recommended junction type is the roundabout.

Design solutions of urban roads

Érd – road diet, lane reduction from 4 to 2, parking lanes, taxi station, roundabout in the city centre.

Design solutions of urban roads

Hamburg – road diet with parking lanes

Copenhagen – road diet with middle green lane

Design solutions of urban roads

Pottstown, USA
main street, bicycle lane, inclined parking

before ↑ **after** →

turning lane in the middle

Source: http://www.fhwa.dot.gov/publications/publicroads/11septoct/05.cfm

Design solutions of urban roads

Nyíregyháza – parking lane

Source : Google Earth

Design solutions of urban roads

Szolnok – possible lane reduction, new roundabout

Design solutions of urban roads

Reduction of speed can be achieved by decreasing the width of traffic lanes.

Solutions for decreasing the width of traffic lanes:

- **middle dividing island at a junction**
- **middle island at a pedestrian crossing,**
- **bicycle lane(s) signed with painting,**
- **roadside parking lane or area,**
- **lane drawing with alternate side parking**

Design solutions of urban roads

Nyergesújfalu – middle islands in a system

Design solutions of urban roads

Important thing is to raise the drivers' attention at dangerous sections and places.

Design solutions of urban roads

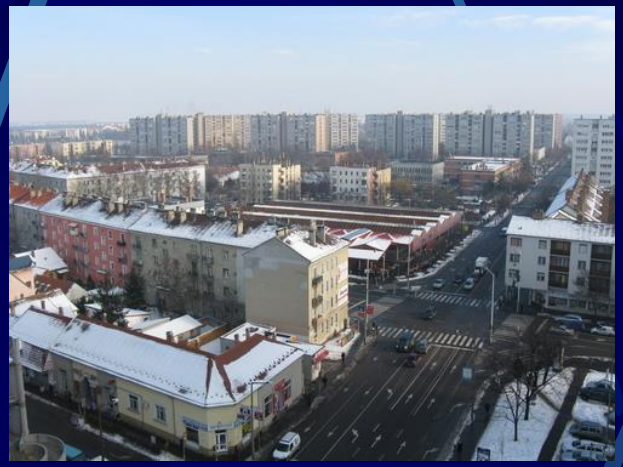
Alignment at the verge of the city centre

- **provides suitable approach and connection,**
- **makes possible to implement a pedestrian zone in the centre as well as tracks for cyclists there,**
- **provides acceptable public transport coverage,**
- **may join to a regional bus station,**
- **provides approach to central parking areas,**
- **requires adequate traffic engineering design**
  - **four traffic lanes,**
  - **roundabouts or aligned signalised junctions.**

Design solutions of urban roads

Szolnok main road at the verge of the city centre

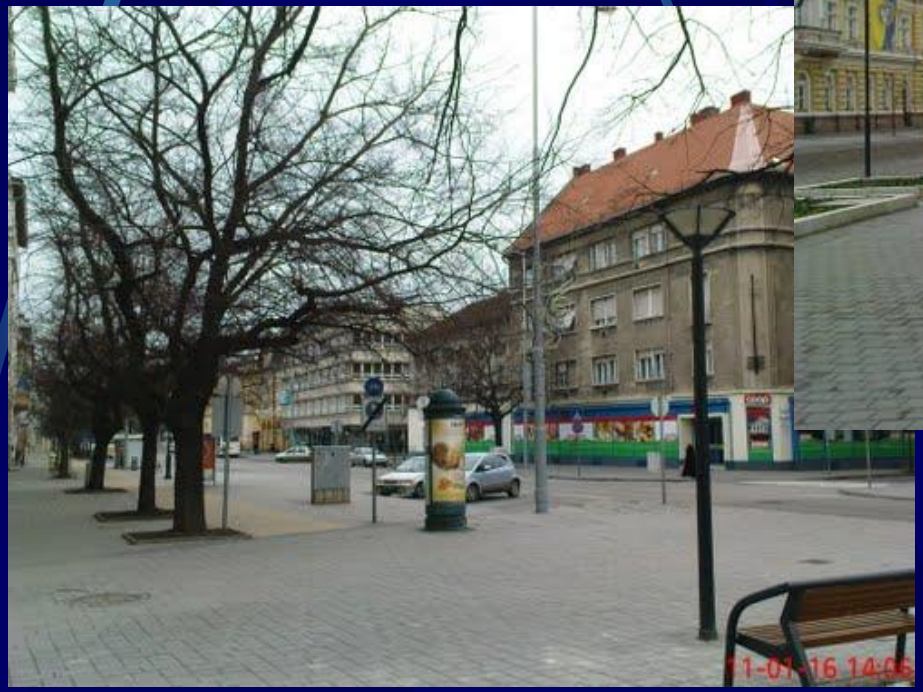
Design solutions of urban roads



Szolnok main road at the verge of the city centre

Design solutions of urban roads

Szolnok pedestrian zone at the former urban section



Design solutions of urban roads

On the urban section of a main road the continuity of the traffic flow may not be prioritised. Even in case of aligned signalisation there may be a well defined stop point.

All left turning movements can be allowed at junctions to provide better approach.

A roundabout at the verge of the city centre helps in perception of the change in driving conditions

An appropriate number of dedicated pedestrian crossings must be ensured.

Design solutions of urban roads

Positive result factors of the proper solution of urban sections:

a) **people like moving in an attractive, humane, green city area;**

b) **shops are better placed into a high quality urban environment;**

c) **approach by car is possible but it cannot be dominant;**

d) **other transport modes (public transport, bicycle and pedestrian) are well developed.**

Summary 1.

An urban road requires a complex approach because besides the traffic function there are other urban functions.

Travelling people and the road are in interaction depending on the place and shape of the road.

Traffic calming is possible without physical means.

The road traffic must be fitted to urban functions.

The basis of traffic planning is the relationship of traffic volume, traffic density and speed.

Summary 2.

In case of smaller settlements the traffic planning of the bypass road can be performed by a simplified method.

The settlement gate emphasises the changing of traffic circumstances for drivers.

Cross section of the urban road is adapted to the remaining traffic volume.

Reduction of speed can be achieved by decreasing the width of traffic lanes.

On the urban section of a main road the continuity of the traffic flow may not be prioritised.

Thank you for your attention!

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