Transport Planning
guideline and manual to best practice
METRASYS - Sustainable Mobility for Mega Cities

The project METRASYS – Sustainable Mobility for Mega Cities is one of ten projects funded by the German Federal Ministry of Education and Research as part of the scientific program “Research for Sustainable Development of the Mega Cities of Tomorrow – Energy and Climate Efficient Structures in Urban Growth Centres”. With the topic of mobility and transportation in its focus, the project deals with one of the most exigent problems of current and future mega cities and metropolitan regions.

During the development and realization phase, the Transportation Studies Group of the German Aerospace Center (DLR) is the lead partner of the METRASYS project. Among the German partners are Wuppertal Institute for Climate, Environment and Energy, AS&P - Albert Speer & Partner GmbH, Fraunhofer FIRST, LUAX Software Consultancy and Freie Universität Berlin. The Research Centre for Software Engineering Technology (ASEC), the Chinese Academy of Transportation Science (CATS) Beijing, Tongji University Shanghai as well as the Chinese Academy of Science (CAS) are the Chinese project partners.

The German Federal Ministry of Education and Research (BMBF) as well as the Ministry of Science and Technology (MOST) are the funding bodies of the METRASYS project.

The main objectives of the METRASYS project are climate protection, a sustainable development of - and sustainable mobility in highly dynamic economic and urban regions.
The development of sustainable mobility concepts for already existing and future mega cities will be the main task of the project. Due to its high population growth, Hefei in the Anhui Province, China, is predicted to become one of those future mega cities. Sustainable mobility concepts will be developed for Hefei and are to be realized locally in Hefei. In close cooperation with local partners from scientific and administrative organizations, the Chinese and German project partners will develop the concepts. This procedure provides a basis for incorporating the local perception of the problems. Innovative concepts, products and services, which proof to be solid, will be transferred to other urban regions and mega cities.

Integrating the traffic management system within the overall transportation planning and transportation policy framework in Hefei is one objective of the METRASYS project. In 2009, there have been several meetings of the METRASYS team and the Hefei Institute of Planning and Design to discuss special topics of urban and transportation planning.

The METRASYS project team has been asked to develop and promote management-, transport and urban planning guidelines and manuals to best practice that accommodates Chinese urban needs and requirements and develop urban areas in Hefei accordingly.

The “Transport Planning Guideline” is intended to act as a knowledge-base and toolbox – not just for planning, but also as a support for making decisions on different measures. The manual contains a number of tangible examples in Asia, Europe, the United States of America and Australia. The references, measures, traffic densities and calculations mentioned in the “Transport Planning Guidelines” are based on various German guidelines and recommendations.

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Motivation and Targets of Transport Planning

In Hefei in the inner city and in the outlying districts owing to the large size of existing structures access and orientation are often felt to be difficult. The dominance of car traffic is experienced as difficult and disturbing. The broad 6-8-lane roads separate the areas on the two sides; pedestrians and cyclists are obliged to use the peripheral areas, cycle and pedestrian routes are often blocked by parked cars.
Transport planning guideline / manual to best practice

Solutions were presented based on existing examples on the topics

- pedestrian traffic (widths, crossings, shared space),
- bicycle traffic (modes of bicycle lanes, cycle traffic management at bus stops and intersections),
- automobile traffic (cross sections, delivery traffic, parking) and
- public transport (bus lanes, bus stops, bus stations, P&R, priority at signals).
Pedestrian Traffic - general remarks

Pedestrian traffic requires special support by securing appropriately wide and walkable sidewalks that are easy to negotiate along public roads, by a high-quality development of the network of paths that do not run along streets, and by slowing or eliminating road traffic in residential areas and by creating and extending pedestrian-friendly areas downtown and in suburban and residential areas.

All streets have to meet potential use by pedestrian traffic and social activities, such as assembly, as well as store fronts, in the form of work on the side of the road and play areas. The shape the potential uses take varies strongly depending on the frontage development, the use of surrounding areas, and the location and importance of the road for the pedestrian traffic network.

The following should be considered when quantifying the space requirements
- flows of pedestrians can be spontaneous, irregular, variable, and the speed can differ,
- pedestrians may have children’s buggies, umbrellas, shopping bags or luggage with them,
- leisure areas in the street can foster social and neighbourly contacts,
- types, frequency and duration of leisure in different streets can vary sharply (sitting on benches, seeing and being seen, shopping or browsing in shop windows),
- types and duration of leisure also depend on the weather, the season and the residents’ habits,
- house entrance areas, plazas and street corners can be preferred places to play or spend leisure time,
- side spaces are often used to store goods deliveries, materials, trash cans or to park vehicles.
Example for sidewalks in China
Pedestrian Traffic - basic size of traffic space

The basic size of pedestrian traffic space is determined by the basic width and height of the pedestrians and the minimum space for maneuver each requires.

The basic size for leisure areas can only be stayed by way of example, given the diversity of temporal and spatial overlap between the different forms of leisure.

Reference: A, page 96
Example for sidewalks / pedestrian areas
Pedestrian Traffic - pedestrian zones

A pedestrian zone is a traffic area where pedestrians have priority over other traffic participants and tends as a rule to be located within the city. In general, a pedestrian zone is blocked to vehicles, exceptions being indicated by special signage. Thus, deliveries or cyclists can be exempted from the prohibition. Corresponding signage can (temporarily) enable access, whereby the vehicle speed and behaviour needs to be adjusted to that of the pedestrian traffic. Exceptions are in most cases made for vehicles used for local public transportation as well as fire department, police, ambulances, garbage and cleaning vehicles.

Design of the road needs to be adjusted to pedestrian needs, the design impact of attractive surface treatment of the paving and reliance on furnishing of all kinds (benches, street lamps, fountains and trees) is to enhance the leisure time spent in such areas. Pedestrian zones are often lined by stores, restaurants and cafés.
Example for pedestrian zones
Pedestrian Traffic / Shared Space

Shared Space refers to a transport philosophy that suggests the public road dominated by traffic should be rendered safer, quality of life in it improved, and the flow of traffic enhanced. Characteristic issues are the lack of traffic signs, signal equipment and lane markings, and the equal status of all traffic participants, while the ‘right-of-way’ rule still obtains.

The concept was devised for locations where the claims made by pedestrians, cyclists, motorists, urban life, leisure time, and children playing areas etc. overlap. They are destined specifically for vibrant parts of cities or districts and thus also main transport arteries/thoroughfares.

Coexistence in the street requires high frequencies in pedestrian and cycle traffic and few car traffic. The upper ceiling for establishing shared space areas is: per peak hour less than 1,800 cars and less than 80 heavy truck vehicles and busses. Moreover, more than 200 pedestrians and cyclists, of which more than 100 must cross the road. Roads with a special crossing requirement tend as a rule to be short sections. Since in these areas the goal must be special attention by the traffic participants, adjusted speeds and a relocation of parking, the length should be less than 500 m.

The area open to vehicles should be highlighted by using elements such as gutters, trees, street lamps etc. setting them off from the side spaces. In the case of heavy traffic loads, a protective space should be installed in the middle for the pedestrians crossing.
Example for shared space
Pedestrian Traffic - crossing

Pedestrian crossings are necessary on all main roads. Non-motorised traffic participants are sensitive to detours, prefer a straight-line crossing and tend, if there is too far between crossings, to illicit behaviour. Crossing points can be designed as crossing aids, pedestrian crossings, passageways, pedestrian overpasses and underpasses.

**Crossing** aids are bulging sides to the road, central reservations and central islands. In particular in the case of large pedestrian flow, they facilitate people safely crossing the vehicle lane. They also indicate to motorized traffic participants at what points they should expect crossing traffic participants.

**Pedestrian crossings** (zebra crossings) are likewise crossing systems on the ground that are marked by broad lines on the vehicle lane. They may only be deployed in roads where the speed limit is at most 50 km/h and only if the pedestrians need not cross more than one lane in each direction.

**Passageways** are especially safe owing to the use of traffic lights to signal right of way. Central islands as crossing aids should be at least 4.00 m wide and 3.00 m deep to enable people to wait on the island.

**Under- and overpasses** are used if the traffic density exceeds 1,000 cars/h/traffic lane and at intersections with traffic lights it is not possible to achieve tolerable light signal phases for pedestrians. Underpasses require lesser ramp lengths, as they are lower overall. Long underpasses tend not to be accepted by pedestrians. Steps should be the exception for under- and overpasses and should if possible be supplemented by ramps or elevators.
Example for pedestrian crossing

- Narrowing of the road
- Zebra crossing
- Zebra crossing with pedestrian island
- Crossing with traffic light
- Pedestrian underpass
- Pedestrian bridge
Pedestrian Traffic

Example for sidewalks / pedestrian crossing

1. Japan
2. USA
3. Germany
4. France
Example for pedestrian areas
Cycle Traffic - general remarks

Cycle traffic can be subdivided into everyday cycle traffic, tourist cycle traffic and cycle road racing. These types of traffic are subject to different conditions that result from the different requirements, origin and destinations. Cycle traffic usually takes place all year round in the form of everyday traffic. In particular when the weather grows warmer, there is a large tourist component. Cycle road racing accounts for only a small proportion of overall cycle traffic.

Cycle traffic requires a structural and legal infrastructure that enables smooth expediting of the cycle traffic between its origin and its destination. The origins and destinations of everyday cycle traffic are identical with those of other types of traffic. For this reason, the existing road network usually also functions as a basis for cycle traffic. Given that it is muscle-powered propulsion, everyday cycle traffic relies on routes that are as short as possible, with as few detours as possible, few if any climbs and smooth, easy to ride road surfaces. As a rule, the existing road network suffices to this end. For tourist cycle traffic, routes are preferred that do not use busy roads. Often the direct line between two locations is avoided in favour of tourist destinations that can be reached along the way. Also, a poorer road surface is tolerated on tourist cycle paths.

The average speed for cyclists is 10-20 km/h for those who are not cycle enthusiasts. A cycle with limited pedal support (Pedelec) helps riders achieve a speed of 25 km/h.
Example bicycle
Cycle Traffic - basic size for traffic spaces

Cycle traffic facilities should guarantee or improve traffic safety and the quality of traffic flow. The basic sizes for planning traffic space for cycle traffic can be derived from the basic width and height of a cyclist and the related scope for manoeuvre.

Basic size for traffic spaces for bicycle traffic:

Reference: A, page 96
Example for basic sizes
Cycle Traffic - modes of bicycle lanes

The *protective strip* is part of the carriageway. It may only be used by cars if specifically necessary. Protective strips are highlighted by a dotted white line. This measure is used if the lane width is not large enough to create a separate cycle path or cycle lane. A protective strip is 1.50 m wide or rather at least 1.25 m wide.

*Cycle lanes* are special lanes that are separated from the main driving lane by a continuous white line. Cycle paths are as a matter of principle routed in the same direction as the other traffic. Motorized vehicles are forbidden from driving or parking on the cycle lanes. Cycle lanes should be 1.85 m wide, with speed limits of over 50 km/h they should be at least 2.00 m wide. The adjacent driving lane for motorized traffic should be at least 2.75 m wide.

*Clearly built cycle tracks* are located on the side of the road and are separated from the lane by curbs, park or green strips. In principle, cycling is only permitted on the cycle track to the right of the driving lane. Separate cycle tracks may only be used in both directions if there is corresponding signage. The standard width of cycle tracks is 2.00 m and enables overtaking. There must be a safety zone between the cycle track and neighbouring areas.
Example for modes of bicycle lanes

- protecting strip
- bicycle lane
- separated bicycle lane
Cycle Traffic - modes of bicycle lanes

Bidirectional cycle tracks are cycle paths on one side of the road that can be used by cyclists in both directions. They should only have a few intersections, junctions and highly-frequented exits/entrances to property and it should exist a high visibility for the cycle traffic running the opposite direction and the motorized traffic. The width of the bidirectional cycle tracks should enable cyclists to pass at a sufficient distance from each other. The standard is 2.50 m if on both sides of the road and 3.00 m if the cycle track is only on one side.

In the case of joint use with pedestrian traffic there should be no difference in height between the cycle path and the adjoining pavement so as to minimize the risk of falling for cyclists and visually impaired pedestrians. Cycle paths should, however, always be visibly demarcated from sidewalks. The sidewalk should enable pedestrians to advance unimpeded. Cycle traffic in pedestrian areas can unsettle and endanger pedestrians. For this reason, joint use is only acceptable where there is little crossing and standstill of both forms of traffic. The following exclusion criteria apply:

- roads with intensive commercial use,
- main cycle traffic links,
- gradients over 3 %,
- crossing of boundaries as in the image to the side

The width depends on the intensity of use by cycle and pedestrian traffic and in the case of low intensity of use is at least 2.50m.
Example for modes of bicycle lanes

- Shared sidewalk for pedestrian and cyclist
- Bidirectional bicycle lane
Cycle Traffic - modes of bicycle lanes

Cycling the wrong way down one-way streets
In one-way streets with a speed limit of less than 30 km/h cycle traffic can be permitted in both directions on the carriageway. Where there is sufficient opportunity for avoiding each other, streets from 3.00 m in width are suitable for vehicle and cycle traffic to travel safely in different directions. Where there is bus or heavy good traffic the street should be at least 3.50 m wide. Where possible, parking strips should be laid out on the left-hand side in the direction of the one-way street, as the entrances to property and empty parking spaces provide room for avoiding oncoming traffic and the danger from opening doors is reduced through direct eye contact. In one-way streets with over 400 vehicles per hour cycle lanes in the opposite direction of the traffic can be considered where the speed limits is 30 km/h. The width of the carriageway to be kept free from parked vehicles should be at least 3.75 m.

Cycle traffic in pedestrian traffic areas
Pedestrian areas are intended for free and unimpeded movement on foot. Cycle traffic is permitted as an exception and should only be considered if there are important destinations for cycle traffic there. In addition to the width of the area and the level of pedestrian traffic, the use of the sides and the features in the street, the type of cycle traffic (everyday, schoolchildren, through traffic, leisure), as well as the structure and surface are criteria which have to be considered in permitting cycle traffic. In cases of up to 100 pedestrians per hour and meter of street width there can be a complete mixture of pedestrian and cycle traffic. Where there are between 100 - 200 pedestrians per hour and meter of street width, it is recommended that cycle traffic be channelled in a special lane by means of corresponding features and choice of material. More than 200 pedestrians per hour and meter of street width often produce critical situations - cycle traffic should not be permitted here.
Example for bicycle modes

cycling contrary to the one-way street

cycle traffic in pedestrian areas
**Cycle Traffic - cyclists at bus stops**

The design of cycle lanes at bus stops is determined by the width of the space at the side. Where there is sufficient room available the width of the cycle path is kept the same and it leads past the waiting zone behind the area for getting on and off the bus. Where the space is restricted the width of the cycle lane in the bus stop area can be reduced to 1.00 m. Where only little space is available the cycle lane can be turned into a joint pedestrian and cycle lane at the narrow. In this case the relevant section must be designated by the clear use of different material or by markings.

The passengers and the cycle traffic must be able to see one another. For this reason structures (e.g., bus shelters) should be for the most part transparent and not have any advertising.
Example for cycle lanes at bus stops
Cycle Traffic - cycle traffic at intersections

In good time, and from all directions, intersections must be recognizable, comprehensible, clear, and easy and safe to negotiate. As such, cycle traffic has the following requirements:

- Sufficient visibility between the cycle traffic and other road users must be guaranteed,
- the intersections are swift and safe to cross (avoiding narrow radii and high curbs),
- enough sized waiting areas should be reserved for cycle traffic.

Where there is a particular need for cycle traffic to turn left, special provisions must be made for those cyclists doing so. If no turning lane is required for vehicle traffic, a divided middle island can be used (see image). The area in which it is positioned between the lane dividers serves cycle traffic as a protected area in which to wait for gaps in the oncoming traffic.

At intersections with traffic lights it makes sense to colour the cycle traffic lane in the approach so as to heighten awareness of the cycle traffic.
Example for cycle traffic at intersections
Cycle Traffic - cycle traffic at intersections / stopping spaces

At intersections the risk of accidents involving cycle traffic must be kept as low as possible. Design measures include prepositioned stop lines and widened cyclist strips.

**Prepositioned stop lines**
In principle cycle traffic should be able to take up position and approach in sight of vehicle traffic. For this reason the stop line for cycle traffic should be 3.00 m – in the case of heavy cycle traffic 4.00 m to 5.00 m in front of the stop line for vehicle traffic. Short distances in between lead to a danger of cyclists getting into a blind spot in front of and beside trucks.

**Widened cyclist waiting strips**
Prepositioned stop lines create widened cyclist waiting strips for cycle traffic across the entire width of the traffic lane. The prepositioned stop line indicates where vehicle traffic must stop. Where possible at intersections, widened cyclist waiting strips should be combined with protective lanes or cycle lanes, so as to enable cycle traffic to pass stationary vehicles.

The area in front of the stop line should be 3.00 m to 5.00 m long and clearly indicated for cycle traffic through the bicycle pictogram.
Example for cyclist areas on intersections
Cycle Traffic - parking bicycles

Bicycle parking is a cornerstone in the promotion of cycle traffic. Cyclists being able to leave their bicycle easily in a safe place close to their destination is a prerequisite for making cycling attractive as a means of transport.

Good parking facilities encourage people to also use expensive (and as such safe and attractive) bicycles to get to as many destinations as possible. Where there is a lack of facilities, bicycles are left unchained to anything, or chained in a disorderly fashion in unsuitable places to street furniture, inferior-quality bikes are used, or people do not even use a bike at all. Particularly after a bicycle has been stolen people use bicycles of a lower quality, and less frequently.

The posts of traffic signs and street lamps, trees, tree protectors, railings, fences, bollards and many more street and building fittings serve as bicycle stands, without their having been intended to do so. For the most part they are easy to use as such. Their being used as such is frequently a clear indication of the lack of, or insufficient number of suitable facilities for parking bicycles.

Requirements of bicycle parking facilities:
- Bicycle parking areas must be sufficiently big,
- easily accessible at the place of residence and positioned as close as possible to entrances at destinations,
- guaranteed safe parking, easily accessible, and be acceptable in terms of the urban fabric,
- for long-stay parking offer protection from the weather and be vandalism-proof.
Example for bicycle parking
Cycle Traffic - types of bicycle parking facilities

With a **front wheel fork** holder the entire front wheel, including the fork, can be inserted, thereby preventing the bicycle from falling over.

**Stand railings** support the bicycle frame in at least two places, thus providing a firm hold, even when the bicycle is being loaded. As a rule a support stand has parking space for two bicycles. The frame and the wheels can be securely chained to the stand, meaning that it is also protected from being stolen. The distance between the stand railings, which are intended to be used on both sides, should not be less than 120 cm.

If there is considerable need for bicycle parking facilities and insufficient space available, vehicle parking space can also be used for erecting **fixed bicycle stands in streets**.

Like multi-storey car parks for cars, big cities also have bicycle parks so as to better exploit the scarce inner-city space and relieve streets of parked bicycles. For a fee, locked, guarded bicycle parks provide protection from theft for (valuable) bicycles.
Example for bicycle parking
Bicycle Traffic

Example for bicycle parking
Example for cycle lanes
**Floating vehicle traffic**

The function of city and main roads is to provide a link, and access. The requirements in terms of usage can be very different. In the case of roads that mainly perform a linking function, for example on suburban areas with facilities in surroundings that are located at a distance or face away from roads, an even flow of traffic has precedence. With regard to inner-city roads with a high concentration of offices and businesses, requirements relating to their being easy to reach dominate.

The requirements in terms of usage can be dictated by location and surrounding facilities and arise at specific times of day (e.g., commuter and shopping traffic) as well as be subject to local fluctuations along a road (e.g., business areas).

In determining the amount of space required for the floating vehicle traffic, particular attention must be paid to the fact that
- the defining vehicle for surveying purposes is the largest registered vehicle,
- the amount of space required is primarily determined by the defining case of passing traffic, and
- opting for smaller traffic areas does not necessarily result in an appropriate manner of driving.
Example for street design
Automobile traffic - basic size of traffic areas

The basic size of vehicle traffic areas is derived from the size of vehicles and the maximum upper and sideward room for movement required for the manner of driving selected.

The basic size of traffic areas in the case of oncoming traffic, vehicles travelling beside one another, and past driving vehicles, is derived by adding supplementary width determined by the individual situation to the width of traffic areas. This amounts to 0.25 m in the case of cars and trucks encountering, travelling beside, and past one another. The vehicle clearance envelope encompasses the individual vehicles' traffic areas, as well as side and upper clearance distance. Beside travelling and stationary vehicles the clearance distance is 0.50 m. The upper clearance distance is always 0.30 m.

Basic size of traffic areas for various vehicles used for surveying purposes:
Example for basic sizes of traffic areas

Reference: A, page 96
Automobile traffic - cross sections

Traffic lane cross sections that have the same width over long sections are not appropriate for city streets, as given the dependence on the building structure, the surrounding facilities and the different usage requirements at different times of day, the function of individual sections can change.

Basically, with regard to demarcating traffic lanes a difference is made between the dividing principle and the mixing principle. In the case of the **dividing principle** a separate traffic lane is created by means of curbs, side gutters, or gutters. The **mixing principle** is an endeavour to make several uses as compatible with one another as possible by means of intensive design measures. This is attempted by making the entire road level or by speed reduction elements such as speed bumps in some places.

The width of traffic lanes depends on the volume of bus and heavy traffic, the manner in which cycle traffic is directed, and the amount of space available. In the approaches to intersections, narrower lanes are applicable if this is the only way to create waiting strips, side space or central islands.
Example for mixing and dividing principle
Automobile traffic - carriageways

**Two-lane carriageways** on main roads are as a rule 6.50 m wide. If there is few bus traffic they are 6.00 m wide, and if there is a low frequency of trucks can be reduced to 5.50 m. A high frequency of busses and trucks meeting when travelling in opposite directions dictates that the width be 7.00 m. Two-lane carriageways accommodate cover a wide range of possible traffic volume. Indicative figures for the capacity of two-lane sections lie between 1,400 and 2,200 vehicles per hour.

**Four-lane carriageways with a median** consist of two-lane carriageways in each direction, which as a rule are 6.50 m wide. In the case of low levels of bus and delivery traffic they are 6.00 m wide, and if traffic is predominantly busses and delivery vehicles, 7.00 m. Indicative figures for the capacity of four-lane sections lie between 1,800 and 2,600 vehicles per hour in each direction.

**Four-lane carriageways without a median** have the same lane width as those with one. These are, however, only feasible if there is an extremely limited amount of space available and a low level of bus and heavy traffic. They are difficult for pedestrians to cross and only expedient if the adjoining intersections have the relevant capacity as well and central islands can at least be accommodated in places.

**Extra-wide two-lane carriageways** enable the flexible use of parts of carriageways, for example delivery and loading traffic and limited parking. Extra-wide two-lane carriageways are between 8.50 m and 10.00 m wide.

**One-way-streets** and **single-lane carriageways** have lanes that are 4.25 m wide on main roads; where there is limited space available the width can be reduced to 3.00 m.
Example for carriageways

one-way road

two-lane carriageway

four-lane carriageway without a median

four-lane carriageway with a median
Automobile traffic - delivery traffic

The level of delivery traffic depends on the number, manner, and size of businesses (service, trade, commerce), the peculiarities with regard to what these offer, the deducible frequency of deliveries and the size of the vehicles used.

Typical conflicts involving deliveries and loading occur on two-lane roads through delivery vehicles double parking. With regard to the space required for deliveries and loading, it should be noted that:
- in the morning deliveries of food and beverages predominate,
- fixed delivery times can generally not be guaranteed,
- in individual cases though, relatively regular delivery habits can be observed (approx. 60 % head for the same company at the same time of day and 80 % always do round trips),
- deliveries are to a large extent made from the road, and
- the parking time primarily depends on the size of the delivery.

Basic sizes for delivery and loading facilities are determined by the size of delivery vehicles, by the additional space required for the vehicles’ rear lifting mechanism and by the space needed for the short-term depositing of the goods by the vehicle.

Vans and small trucks require loading space that is at minimum 2.3 m wide and 10 - 12 m long. Trucks require minimum space measuring 2.5 m in width and 12 - 14 m in length. Additional side space measuring between approx. 3 and 5 sq. m. should be envisaged for the short-term depositing of the delivered goods.
Example for delivery traffic
Automobile traffic - parking

The usage requirement of stationary cars results from the access function of the adjoining roads. They are particularly large in sections and areas with lots of businesses, offices, and a high density of residential accommodation. The demand occasioned by these forms of use can, however, seldom be catered for on the relevant land.

The demand for parking in a road varies enormously depending on what it is used for. Whereas on main roads in big cities with a high density of business areas there is a high demand for short-term on-road parking, in the case of residential roads there is more long-term parking.

The basic size of parking space for cars is determined by the size of the vehicle used for surveying purposes, the preferred manner to enter and leave the parking space (forwards/backwards, with/without manoeuvring) and by the style of parking (parallel parking, angle parking, perpendicular parking). In order to be able to get in and out of a parked vehicle in comfort a gap of 0.75 m is required between it and fixed obstructions to the side. For parking spaces reserved for wheelchair users there must be a clear distance of 1.75 m on side of the vehicle. From here there must be direct barrier-free access to the sidewalk.

Reference: C, page 96
Example for parking
Public Transport - general information

On city streets public transport is possible on tracks and in specific traffic lanes. As a rule the traffic lanes are laid out on main roads. They are important elements in prioritised public transport systems. As such they serve to
- ensure the regularity and punctuality to as great an extent as possible,
- minimize external hindrances, in particular from vehicle traffic, and
- increase the time of travel with the public transport.

These goals can be achieved by separating private from public traffic by means of traffic lanes that are reserved for unlimited and limited periods of time. Public transport lanes can be laid out for the entire length of roads, for individual sections, or just at intersections.

Public transport traffic lanes can be laid out in the middle or at the side of roads. Those in the middle have the advantage that vehicles parked illegally do not present an obstruction. If possible the safe, smooth flow of traffic ought not to be disturbed by cross traffic. If a reserved traffic lane is laid out on the side of the road it must be ensured that conceivable disturbances to the journey are prevented. Switching a public transport lane from the middle to the side of a road and manoeuvring from the middle into the regular vehicle lane requires the transition area to be designed in a particular way, and should basically involve a set of traffic lights.
Example for bus lanes
Public Transport - bus lanes

Side bus lanes in operation for unlimited periods of time can be used wherever there is no residential traffic or loading and unloading is conducted from relevant special areas, as otherwise illegally parked vehicles can block the special bus lanes.

Alternatively side bus lanes can be laid out for use during limited periods of time. The limited period of time for which the bus lanes in a particular city are reserved should be identical. In general road users accept and observe separate lanes. Misuse is more frequently observed when traffic lanes are only reserved for public transport at specific times.

The design of bus lanes can be deduced from the basic data of the busses in operation. As a rule they are 3.50 m wide, but where there is only limited space available the width can be reduced to 3.25 m.
Example for bus lanes
**Public Transport - bus stops**

The location of bus stops should be selected such that passengers can reach the public transport vehicles easily, safely, and within a short distance. The same applies at stops when passengers change from one means of public transport to another.

Stops at intersections can be located before or after these. Whenever public transport vehicles have priority at traffic lights, a stop after the intersection has the advantage of also enabling cross traffic to move off after the bus has entered the stop. At stops before intersections controlled by traffic lights public transport vehicles can be shown the relevant light signal by a separate traffic light prior to other traffic. This way public transport is assured of moving off in front of the following vehicles. Bus stops should be located as close as possible to intersections as this will make it easier to reach them and cross the road.

**Bus stops in the middle of the road:**
The length of the bus stops is determined by the number of vehicles, which the bus service dictates, must be able stop there at the same time. The usable width of bus stops islands should not exceed 2.50 m. Greater widths are recommended for stops where passengers change transport, and double bus stops.
Example for bus stops
Public Transport - bus stops

Bus stops at the side of the road:
Where bus stops are located at the side of the road busses can stop at bus capes, in the road or in bus bays.

*Bus capes* enable busses to approach the edge of the stop directly and accurately, enable them to move off again in a straight line in the lane they were using and put them at the front of the throng of vehicles. They make it easier to keep bus stops free of parked vehicles and do not need to be long. Compared with bus bays they increase the amount of space for waiting passengers, thereby increasing safety. Bus capes influence the quality of traffic flow for motorized private transport. In the case of a 10-minute headway or more as well as medium stops of 16 seconds, bus capes are always possible.

*Bus stops at the edge of the carriageway* have the advantage that they can be built using few construction means. However, parked vehicles will probably be a hindrance. If parking is permitted at the side of the carriageway, the length of the bus stop must be marked according to the dimensions on the carriageway.

*Bus bays* may be necessary on account of the volume of traffic or for operational reasons. Directly after intersections, stopped busses should not hinder the following traffic. For this reason bus bays are worth considering there. Bus bays before intersections should enable busses to reach the intersection directly after pulling out. The fact that they have to rejoin the other traffic again is a disadvantage, which in the case of heavy traffic leads to them losing time. Standing passengers and those preparing to alight can experience unpleasant sideward acceleration as they approach and leave bays. Bus bays should be 3.00 m deep.
Example for bus stops

- Example for a bus cape
  - Bus length + 20 m
  - Dimensions of a bus stop
    - Min. 20 m

- Example for a far-side stop
  - Bus length + 20 m
  - Bicycle
  - Dimensions of a bus stop
    - Reference: D, page 96

59 - Transport Planning Guideline
Public Transport - waiting areas

The dimensions of side waiting areas are determined by the dimensions of the bus shelters and the space needed for getting on and off and walking the length of the bus.

Reference: D, page 96
**Example for waiting areas**

1. Bus bulb
2. Bus stop with bus bay
3. Stop at edge of lane
The bus station should basically be located outside the general traffic area so as to avoid hindrances from private transportation. Bus stations must have efficient links to the road network.

In the design of bus stations it is as a rule assumed that the individual bus routes will be allocated specific departure points. IT-supported information systems can be used to allocate stops to busses dynamically as well.

Where there is a large number of bus routes with a high volume of passengers changing from one to the other, bus stations with an interior stopping island are desirable. The shape of the island depends on the space available and the requisite stopping positions. In order to reduce the length of the island and thus shorten the distance needed to change vehicles, the edge of the stop can take the shape of saw teeth. All solutions featuring interior stopping islands are characterized by short distances between the stops with no need for passengers to cross bus lanes.

Where comparatively little space is needed, by arranging the stopping points at individual platforms, a large number of routes can be accommodated in a single facility. Overall, diagonal platforms save space and enable a more slender design of the facility. Arranging the platforms on the perpendicular requires wide lanes for driving in and out. Only with a sufficiently wide entrance will the driver be able to position his vehicle parallel to the platform.

Separate space is required for parking busses during breaks.
Example for bus station

bus station with internal bus stop island

angle positioning of busses

bus station with internal bus stop island - in form of saw-teeth design

orthogonal positioning of busses

Reference: E, page 96
Public Transport - bus station

*Example for bus stations - bus stops on separate bus platform*
Example for bus stations - with internal bus stop island
Public Transport - bus station

Dimensions

The following dimensions are examples from German guidelines “planning, construction and operation of bus terminals”

**Effective length (Lₜ)** without independent entrance and exit

**Effective length (Lₚ) at independent exit**

**Effective length (Lₚ) at independent entrance and exit**

Dimensions of parallel bus stops

Dimensions of angle bus stops

Reference: E, page 96
- Transport Planning Guideline

- pedestrian crossing
- bus station with parallel stops
- reversing track loop

Reference: E, page 96
Public Transport

Example for bus stations
Example for bus stations
Public Transport - bus station

Passenger Areas

As a rule, passenger waiting areas are allocated directly to the individual bus stopping areas. The length of the passenger waiting area is determined by the length $L_n$ of the bus stop that the bus service dictates. The width of the passenger waiting area ($B$) can be calculated on the basis of the deciding volume of traffic:

$$ B = \frac{F_e + M_{\text{max}} \cdot F_f}{L_n} \quad [m] $$

$F_e$ = space for structures at the bus bay [sq. m.]
$M_{\text{max}}$ = peak occupancy of the bus platform [waiting passengers]
$F_f$ = passenger space requirement [sq. m. / passenger]

In order to guarantee that there is sufficient space to move, the passenger space requirement should apply more than 1.5 sq. m. / passenger. With regard to convenience getting on and off vehicles, the width of the platform should be made as generous as possible. The minimum width should not be less than 2.50 m.

Calculation information:
The capacity of a sidewalk is approx. 1,700 pedestrians per hour and 1 m width. Fixed steps of 2.40 m width can accommodate 140 pedestrians / minute going up and 180 going down. If the steps are 3.00 m in width the maximum capacity is approx. 175 pedestrians / minute going up and 225 going down.
Example for passenger areas
Public Transport - information and facilities

Passenger information is an important element in local public transport communication and a fundamental prerequisite for the services to be accepted. An attractive information policy can dismantle barriers with regard using local public transport and ultimately be an influencing factor in favor of choosing local public transport for a journey. With all passengers in mind, finding one’s way around the local public transport system should be as straightforward, and using it in general as easy as possible.

Passenger information is information for users of public transport that provides them with a wide range of details about operational procedures. The information can be about time-related matters, local circumstances or rate agreements. Passenger information is provided using visual and acoustic systems (display panels, loudspeakers).

The information must be easily perceptible, clear, quickly comprehensible, well structured, robust and resistant to willful destruction. Bus destination advertisements should be positioned in the relevant waiting areas such that passengers see them on approach.

Other important facilities for passengers potentially include:
- seating / mesh for leaning against
- signposting
- static / dynamic passenger information / information columns
- clocks
- loudspeaker systems
- waste paper bins and ashtrays
Example for information and facilities
Park and Ride

Park and Ride is a principle in traffic planning that involves making parking facilities for cars, and in some cases for motorcycles and buses available in the vicinity of public transport stops. This gives working people an opportunity to leave their car on the edge of town and travel downtown on public transport, avoiding tailbacks and problems finding a parking space.

In terms of construction a P+R facility is no different from the standard parking facilities of car park, parking deck, multi-storey car park and underground car park. The main distinguishing feature is the proximity to a public transport stop, mostly with special, where applicable, sign-posted access. A popular option features the positioning of a multi-storey car park on the side of the tracks of a through that face away from the reception building, such that the bridge or transverse tunnel leads directly to the parking facility.
Example for park and ride
Public transport priority

In certain situations public transport should be given priority over motorized private transport. This is achieved through faster public transport vehicles, automatic green lights for the public transport lane at crossings and traffic lights, as well as through reserved lanes, which may not be used by cars.

Tram lines automatically enjoy phased green traffic lights and busses have their own lane. By means of induction loops in the road surface or radio/infrared transmitters the busses automatically clear a free route over crossings for themselves.

The acceleration program pursues several goals simultaneously:
- unhindered and faster journeys for tram lines and busses, resulting in
- greater punctuality,
- shorter journey times,
- increased attractiveness,
- lower vehicle requirement, hence higher cost-efficiency,
- less driver stress occasioned by the pressure from tailbacks and late arrival.

Green and red light phases are geared to actual traffic conditions and have to give priority to streetcars and busses.
Example for public transport priority

1. Image of a road with a bus lane marked clearly.
2. Image showing a pedestrian crossing.
3. Image of a road sign indicating a bus lane.
4. Image of a road with a clearly marked bus lane.
Example for public transport

Tram

bus stop on main road
Example for bus stops

1. Japan
2. United Arab Emirates
3. Germany
4. United Arab Emirates
5. Brasil
Cross section

To ascertain the cross-section, typical design situations are demonstrated stating the framework conditions derived from the requirements in terms of usage of pedestrian, cyclist and parked vehicles, the significance in local public transport, the volume of vehicle traffic and the width of the road. These typical design situations cover a significant proportion of the design assignments encountered in practice.

The recommended cross-section is identified by means of the following four steps:

1. **Usage requirements that influence the design**: Allocation to pedestrian and residential traffic, cycle traffic, stationary traffic

2. **Public transport**: Differentiation between no public transport, bus service, and tram

3. **Vehicle traffic**: Differentiation between five classes of peak hour vehicle traffic volume, based on the cross-section

4. **Road width**: The available or planned road widths mentioned are in each case the shortest possible widths for the cross-section portrayed to be used. Should more space be available, the extra space should initially always be allocated to pedestrian traffic. Should less space be available, the exclusion of an element such as a parking lane can be examined.
Determination of a cross section

1. Usage requirement that influence the design:
   - pedestrian parallel the road
   - pedestrian cross the road
   - cycle traffic
   - residential traffic
   - parking and delivery

2. PT
3. vehcl./h
4. road width

Reference: D, page 96

PT: Public Transport
Cross section

**Residential path**

**Characteristics**
- access road
- terraced and detached houses
- residential property only
- short length (up to 100 m)
- traffic volume less than 150 vehicles per hour
- special usage requirement: Residence

**Typical minor conditions and requirements**
- the residence function should be made clear by means of the blending principle
- traffic lane widths should enable cycles and cars to pass one another
- entrance area must be assure against driving and eye contact must be established
Determination of a cross section

Usage requirement that influence the design

- Pedestrian parallel the road
- Pedestrian cross the road
- Cycle traffic
- Residential traffic
- Parking and delivery

Without PT

Pedestrian

Vehicle/h

Road width

400-1000
1600-2600
< 400
800-1800
> 2800

4.5

3.5

2.25

2.25

8.0

2.5

4.0

2.5

9.0

2.5

5.0

2.5

10.0

Reference: D, page 96

PT: Public Transport
Cross section

*Residential street Characteristics*
- access road
- different forms of construction: linear construction, terraced and single-family dwellings
- residential property only
- length up to 300 m
- access function only
- traffic volume less than 400 vehicles per hour
- special usage requirement: residence, parking

*Typical minor conditions and requirements*
- traffic lane widths should enable cycles and cars to pass one another
- if necessary passing places must be decreed for when cars/refuse vehicles meet
Determination of a cross section

Usage requirement that influence the design

- pedestrian parallel the road
- pedestrian cross the road
- cycle traffic
- residential traffic
- parking and delivery

PT: Public Transport
vehcl./h
road width

- without PT
  - <400
  - 800-1800
  - >2600
- with PT
  - <400
  - 800-1800
  - >2600
- tram

Reference: D, page 96
Cross section

**Collector road**

**Characteristics**
- access road
- different forms of construction: frequently linear construction, solitaire building
- principle use is residential with occasional businesses, facilities serving everyday need
- length depending on the size of the development 300 to 1,000 m
- traffic volume 400 to 800 vehicles per hour
- special usage requirement: pedestrian traffic, frequent need for crossing facilities in places, mostly bus service

**Typical minor conditions and requirements**
- frequent excessive speeds, encouraged by the semi-open development facing away from the road
- generally sufficient residents’ parking
- crossing assistance necessary to create sections and reduce speed
- safety for cyclists by means of cycle lanes or effective speed reduction measures
Determination of a cross section

Usage requirement that influence the design:

- PT (Public Transport)
- vehd./h

Road width:

- ≤ 11.5 m
- ≥ 16.5 m
- ≥ 17.5 m
- ≥ 19.5 m
- ≥ 22.5 m
- ≥ 26.7 m

With and without PT:

- Without PT
  - (400-1000)
  - (800-1800)
  - >2600

- With PT
  - (400-1000)
  - (1600-2000)
  - (200-1800)
  - >2600

Cycle traffic and pedestrian cross the road:

- 1 (PT) - 1.6
- 2 (PT) - 1.6
- 3 (PT) - 1.6

Querschnitte abschnittsweise kombinieren

Reference: D, page 96
Cross section

**District road**

**Characteristics**
- access road / main road
- continuous, high-density development
- mixed usage including residential, commercial and services
- section lengths between 100 m and 300 m
- road widths from 12 m
- traffic volume less than 400 to 1,000 vehicles per hour
- special usage requirement: pedestrian traffic, parking
- bus traffic possible, depending on the mixture of uses heavy traffic as well

**Typical minor conditions and requirements**
- the mixed usage results in high demand for on-road parking
- the road design must help improve the quality of the open space
- crossings can all be located at intersections, these areas must be kept free of parked vehicles
- for lengths of over 200 m sections should be created by interrupting parking lanes in combination with speed bumps
**Determination of a cross section**

<table>
<thead>
<tr>
<th>Usage Requirement that Influence the Design</th>
<th>Pedestrian Parallel the Road</th>
<th>Pedestrian Cross the Road</th>
<th>Cycle Traffic</th>
<th>Residential Traffic</th>
<th>Parking and Delivery</th>
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</table>

1) bei $V_{SUL} > 30$ km/h; Gehweg/Radweg frei

PT: Public Transport

Reference: D, page 96
Cross section

**Trunk road with commercial Characteristics**
- access road / main road
- arterial roads are located in the centres of large and medium-sized cities
- high density of businesses, scarcely any residential space
- frequently with bus and tram services
- depending on the size of the city is the section length 300 m to 1,000 m
- traffic volume less than 800 to 2,600 vehicles per hour
- special usage requirement: Pedestrian traffic, parking, delivery and loading, cycle traffic, public transport and residential

**Typical minor conditions and requirements**
- sufficient side space and linear opportunities for crossing are to be envisaged
- given the linear crossings low speeds and eye contact between pedestrians and drivers must be ensured
Determinatio of a cross section

usage requirement that influence the design

- pedestrian parallel the road
- pedestrian cross the road
- cycle traffic
- residential traffic
- parking and delivery

PT (Public Transport)

vehld./h

road width

≥ 16.5 m
≥ 20.2 m
≥ 25.0 m
≥ 30.5 m
≥ 37.0 m

Fußgängerzone

1) Liefern und Laden im Seitenraum

Reference: D, page 96
Cross section

*Roads with business and industry use*

**Characteristics**
- access road / main road
- mostly large lots of land with single buildings
- commercial use: Trade, offices, leisure
- section length 200 m to 1,000 m
- traffic volume from 400 to 1,800 vehicles per hour
- special usage requirement: Delivery and loading facilities, visitor parking

**Typical minor conditions and requirements**
- car-friendly structures
- parking areas can be planted with trees, which are often necessary to demarcate the road
Determination of a cross section

Usage requirement that influence the design:
- pedestrian parallel to the road
- pedestrian cross the road
- cycle traffic
- residential traffic
- parking and delivery

PT: Public Transport

Reference: D, page 96
**Connecting Road**

**Characteristics**
- main road
- mixed forms of construction medium to low density
- residential and commercial use
- section lengths 500 m to over 1,000 m
- traffic volume 800 to over 2,600 vehicles per hour
- special usage requirement: Cycle traffic, public transport

**Typical minor conditions and requirements**
- most parking is on private land
- non-structured roads and low density of usage encourage speeding
- crossing aids are required
- cycle traffic should be separate
Determination of a cross section

Usage requirement that influence the design:
- Pedestrian parallel to the road
- Pedestrian cross the road
- Cycle traffic
- Residential traffic
- Parking and delivery

PT: Public Transport

Reference: D, page 96
References

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