SOUTH AFRICA ROAD FEDERATION

Non-Motorised Transport Practitioner's Course

12 NOVEMBER 2020

Session 6: Planning and Designing for Cyclists

SARF
founded in 1950

Planning and design of cycle ways

1. Introduction - Design concepts for cycling
2. Cycle route network planning
3. Design criteria for cycle routes
4. Cycle lane design by road class
5. Design of cycle crossings
6. Traffic calming for cycling
7. Road signage and markings for cycling
8. Bicycle parking/cycle rental designs
9. Pavement design for cycle routes
10. Practical session

1. Introduction

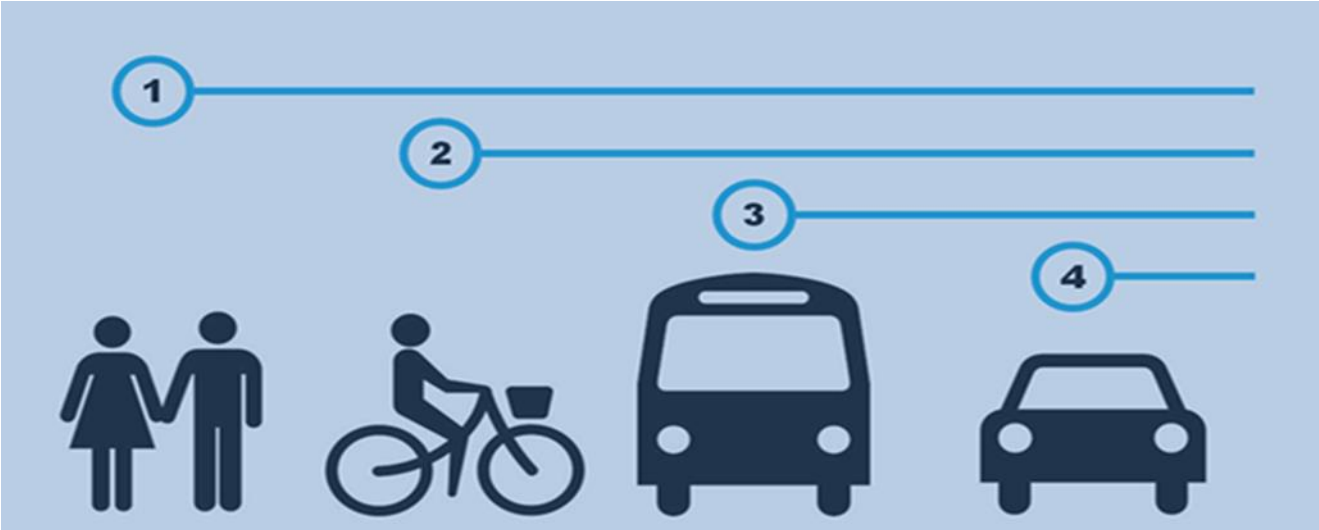
Design concepts for cycling

- **Cycle-able communities**

- **Cycle highways**

Design concepts for cycling

- **Modal hierarchy and sustainable transport**



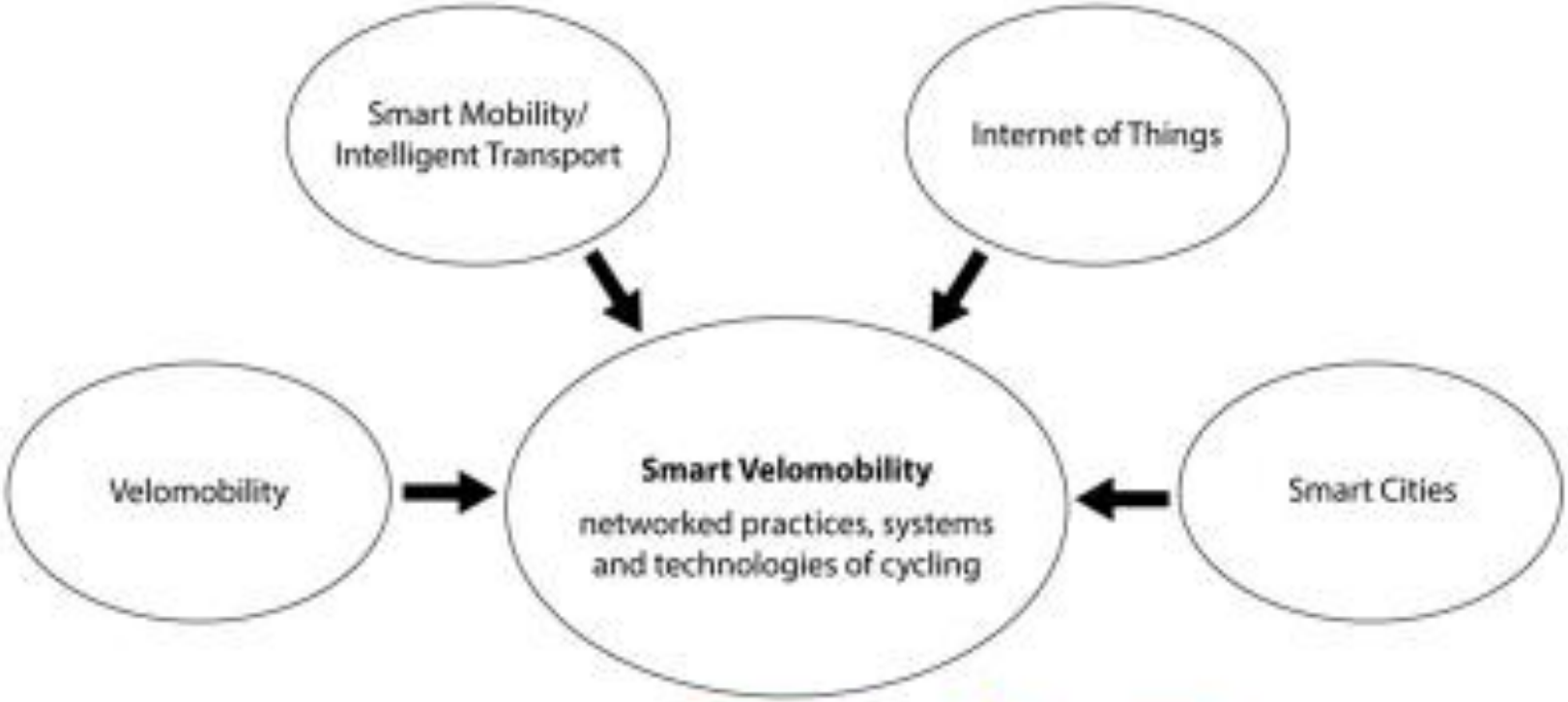
Design concepts for cycling

- **First Mile/Last Mile**

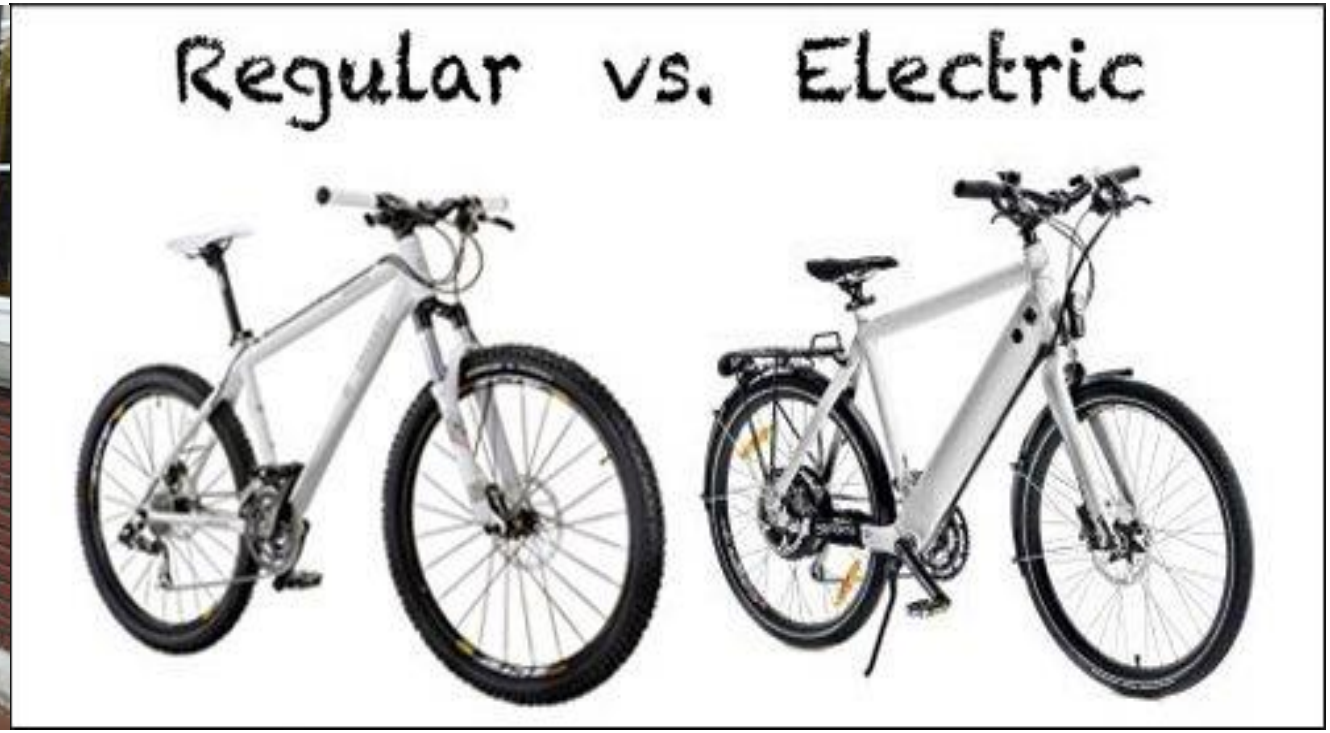
Smart Cities and Cycling

- **Smart velomobility** - concerned with networked practices, systems and technologies of cycling.
- The **benefits** of bicycles pay even more dividends for Smart Cities in the era of connected devices and data-based decision making.
- **Future** devices for bikes and cyclists include smart lights that prevent possible accidents, pedal-powered filters that clean air pollution, and cycle-based sensors that report traffic conditions. Cycle tags and rain sensors to promote mobility at junctions already in some cities.
- As cycling continues to increase in popularity, cities should plan to include cycling technology as **part of their strategy** to become more smart and connected.
- By analysing information gathered by cyclists and bike technology (as for cars) cities can make more **informed *urban planning decisions, design effective infrastructure, prioritize needed upgrades*.**
- In the age of IoT and artificial intelligence, the **simple bicycle** may be one of the most powerful and transformative tools for any Smart City.

Smart Cities and Cycling

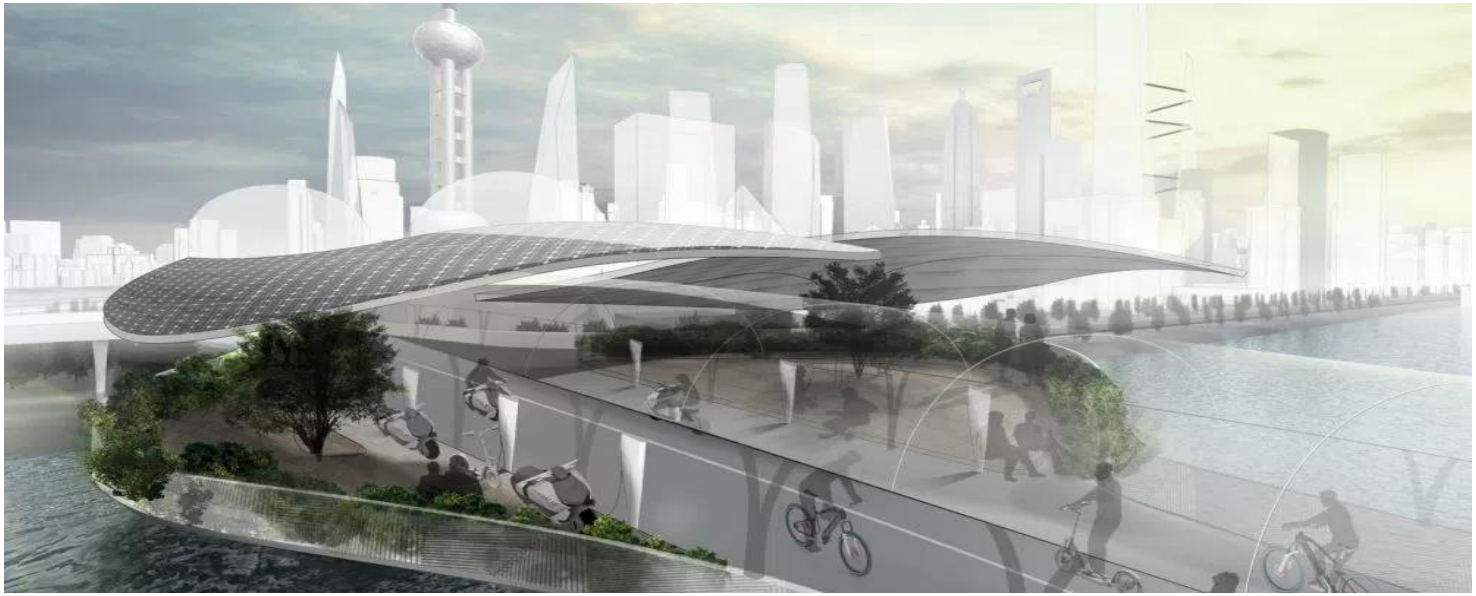


E-bike - a bicycle with an integrated electric motor which can be used for propulsion. Many kinds of e-bikes are available worldwide. For new people to cycling, or for the elderly, it is a revelation – allowing vast new groups to choose cycling as an option
Needs: Road design & Charging stations



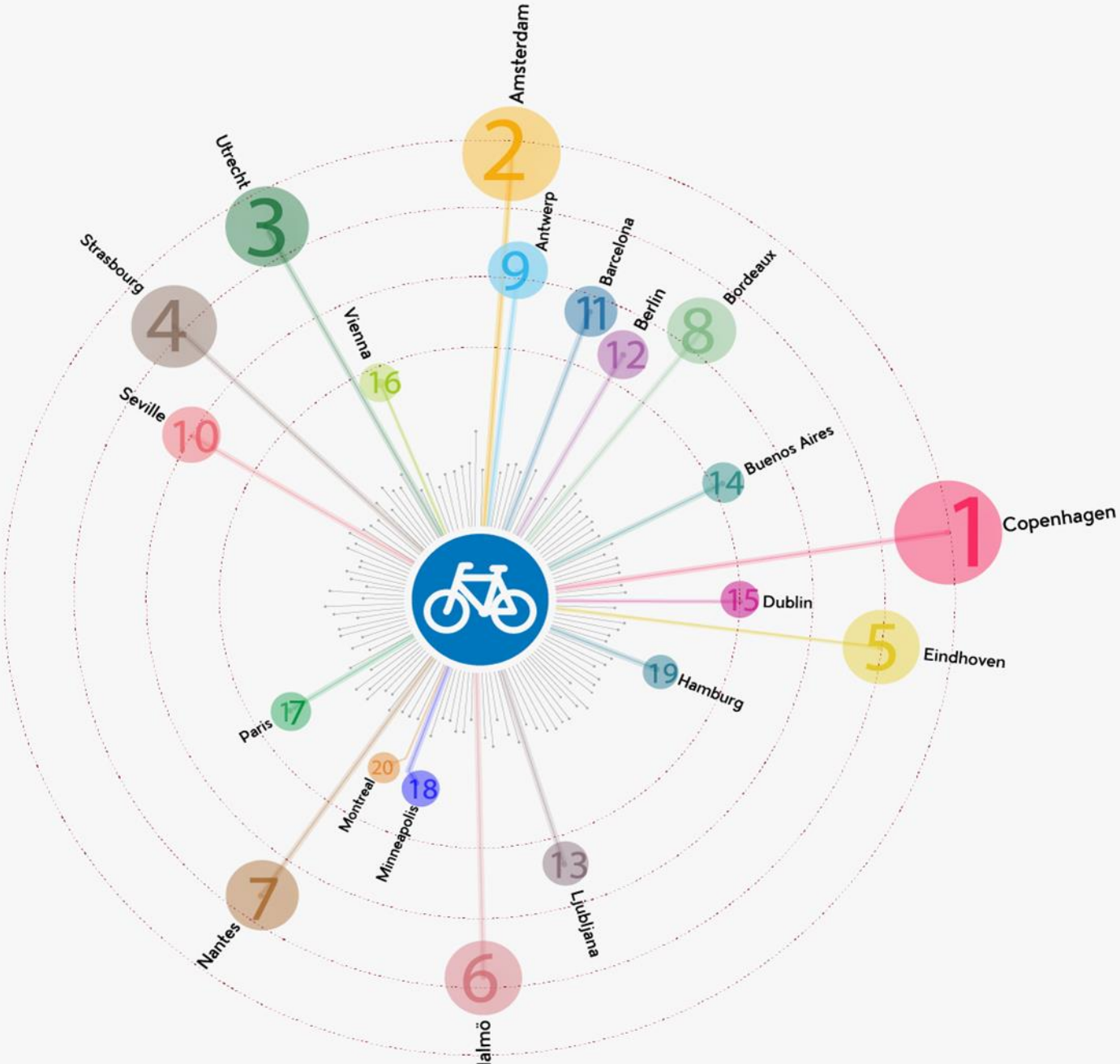
Futuristic View – Designing for e-bikes

BMW and Shanghai University design elevated highways for e-bikes - November 27, 2017



Concept is based on highways that would be used for electric-powered cycles or e-bikes.

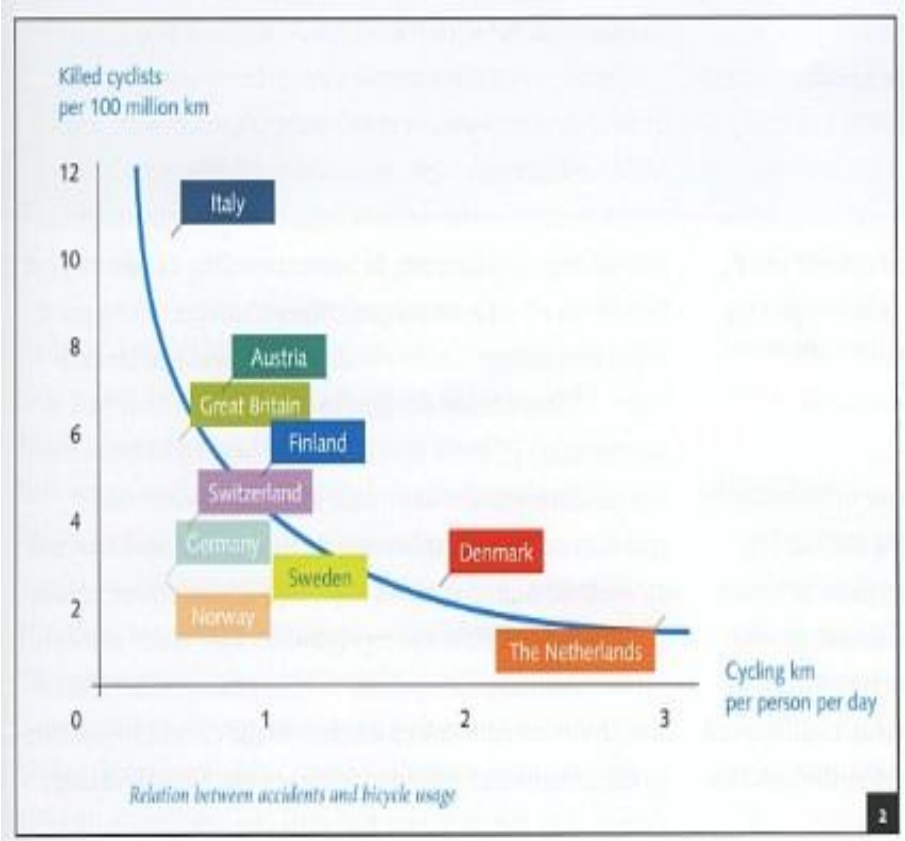
20 most bicycle friendly cities

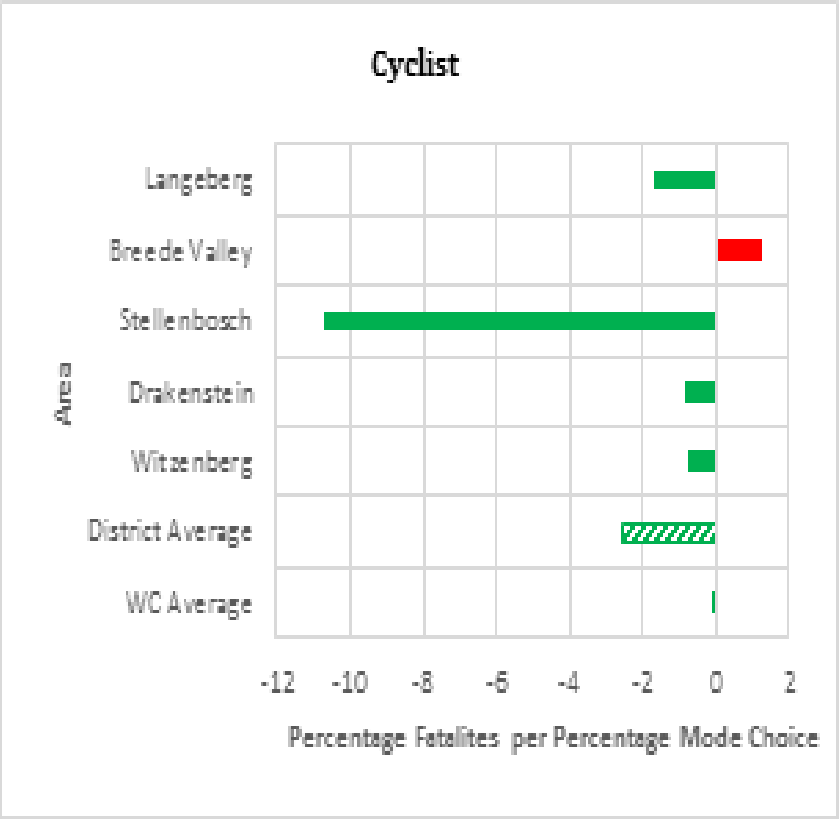


University of Nairobi, Kenya MSc study (2014)

Measures that have contributed to the improvement of school transportation:

- Infrastructure
- Safety devices – e.g. child/cot seat belts
- Driver training
- Education
- Vehicle design





Volume of cyclists vs. Safety of cyclists

<u>More cyclists = fewer casualties - making cycling the new normal</u>

The Bicycle Cities advisor experts say…

Most critical factors to consider:

- Strong political will
- Strong technical skills
- Solid advertising and promotion
- Funding base

Areas of focus:

- Poor areas, those most vulnerable – including schools
- Start simply with deliberate protection of cyclist routes
- Workshops, conferences and to set **task** groups
- **Bike share system and links to public transit hubs**
- Promotion of all success stories
- Outreach to major employers and corporate heads
- Make a strong case for the socio-economic and climate value of cycling

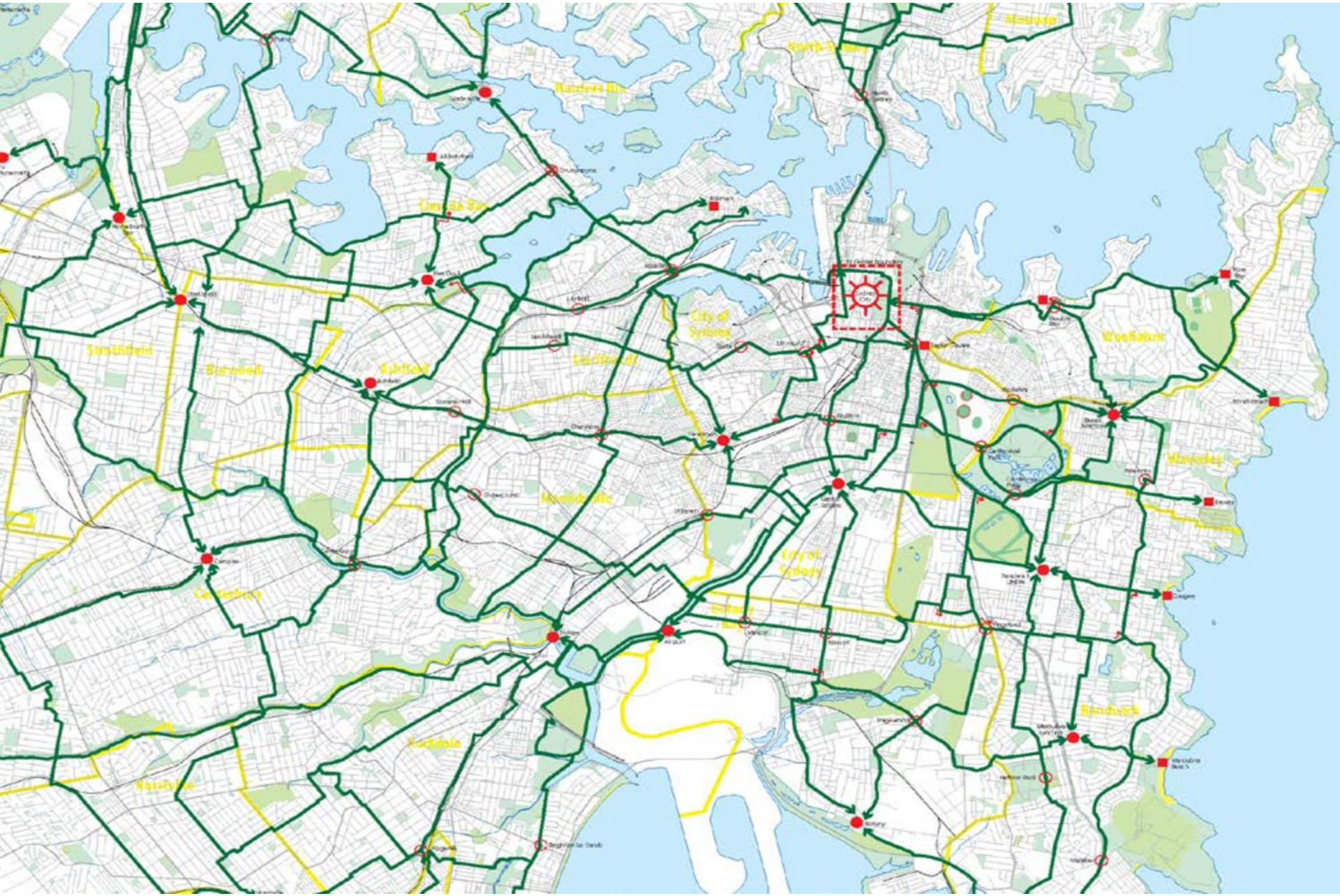
Let’s just make cycling normal

5.5 Million Journeys at NYC Bike Share

Based on origin-destination data released by NYC Bike Share for journeys between July 2013 and February 2014. Idealised route assumed, using OpenStreetMap data.

Created by Oliver O'Brien (@oobr) using Routino and QGIS, at the Centre for Advanced Spatial Analysis at University College London. Further information about the map available at http://oobrien.com/

Cycle network, Sydney, Australia (Austroads AP-R492-15)


Manly
North Sydney
Ryde
Lane Cove
Willoughby
Hunters Hill
Ku-ring-gai
Parramatta
Strathfield
Burwood
Ashfield
Leichhardt
City of Sydney
Randwick
Waverley
Marrickville
Canterbury
Botany Bay
City of Sydney
Sutherland
Rockdale
Kogarah
Bayside
Hurstville
Sydney City
Bondi Junction
Bondi Beach
Coogee
Bexley
Kogarah
Bankstown
Rockdale
Brighton-le-Sands
Botany
Maroubra
Bondi
Randwick

Bicycle groups and road design

- Neighbourhood cyclist
  - School, shops, recreational
  - Recreational, social – focus on practicality rather than fitness
- Commuter cyclist
  - By choice – encouraged by fitness and cost saving
  - Captive market - with rising fuel costs and traffic jams
- Recreational cyclist
  - Racing
  - Tourism
  - Off-road dirt tracks – mountainbiking, cyclo-cross

2. Cycle Route Network Planning

Planning Steps in Cycle Route Network Planning (1) (DoT NMT Manual, 2014)

- Step 1: Develop an Inventory of data (pop/travel/routes, etc.)
- Step 2: Determining Needs of Cyclists
- Step 3: Mapping Existing Facilities, Routes, Bicycle-Related Accidents and Bicycle Volumes
- Step 4: Mapping Main Infrastructure Barriers and Identifying Missing Connections
- Step 5: Assessing and Understanding Potential Demand
- Step 6: Prioritising Bicycle Network Structure including Route Components
- Step 7: Developing Sketch Plan Bicycle Network Structure

Planning Steps in Cycle Route Network Planning (2)

Step 1: Develop an Inventory of data

Planning bicycle routes and networks requires a fair amount of data. Typical questions that need to be answered upfront are:

- Who are the current and potential cyclists?
- What are the different types of cyclists, their cycling skills and trip motives that the network is designed for?
- What is the demand for cycling in an area (frequencies, origins, destinations, purpose/motive, time of the day)?
- What are current hazardous road sections on existing roads that might restrain NMT users from cycling?
- Where can cycle routes be developed?
- What type of cycling provisions or facilities require to bike safely and comfortably?

Planning Steps in Cycle Route Network Planning (3)

Step 2: Determining Needs of Cyclists

- Needs of cyclists differ as they ride their bicycles for different purposes. In SA three types of cyclists commonly seen: the recreational/sports cyclist, the commuting (or utilitarian) cyclist and the scholar/neighbourhood cyclist.
- Commuter cyclists normally adults who bike to work over fairly long distances (up to 15 km or more).
- Scholar cyclists are younger and less adept on their bicycles than adults and therefore need greater protection and more careful planning to ensure that they are safe in the transport environment.
- Recreational/sports cyclists ride mainly for leisure and place a high value on enjoying the experience, so they place more value on open spaces, boulevards, parks and routes separated from traffic.

Planning Steps in Cycle Route Network Planning (4)

Step 3: Mapping Existing Facilities, Routes, Bicycle-Related Accidents and Bicycle Volumes

- Plot a map indicating the location of facilities (bicycle lanes, routes, parking, repair shops, etc.
- Data sets consisting of cycle accident or conflict data, and cyclists' opinions should be mapped.
- Questionnaires can also be used to administer trip purposes, trip frequency, average or typical trip lengths, preferences and social-economic background.
- Special attention should be given to school traffic, as schools may represent points where bicycle users concentrate. Questionnaires and counting parked bicycles are commonly used to assess bicycle demand at schools.

Planning Steps in Cycle Route Network Planning (5)

Step 4: Mapping Main Infrastructure Barriers and Identifying Missing Connections

- Main infrastructure barriers, such as highways, swamps, railway lines, insecure areas, amongst others, that obstruct logical origin-destination connections should be identified and added to the base map.
- These barriers can be the cause of missing links in the existing network.
- As special provisions may have to be made to establish the desired bicycle connections, these barriers require special attention when developing the bicycle network.

Planning Steps in Cycle Route Network Planning (6)

Step 5: Assessing and Understanding Potential Demand

- Potential demand (latent demand) describes potential new trips, currently suppressed, but could take place if cycling conditions were improved. Potential demand assessed in relation to specific route improvements or whole network.
- Measuring potential demand requires understanding factors that influence people's choice of cycling. Surveys of users & non-users, asking about the main constraints (and their order) when to use or not to use a bicycle, are helpful in this case.
- Decision makers can bring some of these factors under control, e.g. in some situations, potential demand is likely to manifest itself when a sustainable safe bicycle network is constructed, or when promotional activities have been undertaken to take away prejudgements on cycling.

Planning Steps in Cycle Route Network Planning (7)

Step 6: Prioritising Bicycle Network Structure & Route Components

- Define and establish the priorities for a bicycle network structure using qualitative or quantitative methods.
- Develop individual bicycle route components that together form routes that are:
  - Safe
  - Coherent
  - Direct
  - Comfortable
  - Attractive

Planning Steps in Cycle Route Network Planning (8)

Step 7: Developing Sketch Plan Bicycle Network Structure

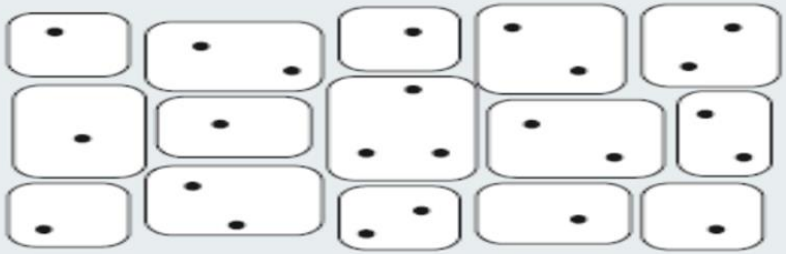
- Information collected in previous steps (base map, facilities, volumes, barriers, demand potential) can be used to develop a strategic outline or sketch mapping of the main NMT network structure by linking and bundling the main origins and destinations, avoiding and/or overcoming the main barriers.

- A GIS system or transport model can be used to do this.

- Alternatively, simple, though very interactive method called ‘Elastic Thread Method’ (Bach, 2006) can be used.

Planning Steps in Cycle Route Network Planning (9)

Step 1: Indentify the main origins and destinations of cyclists for every zone

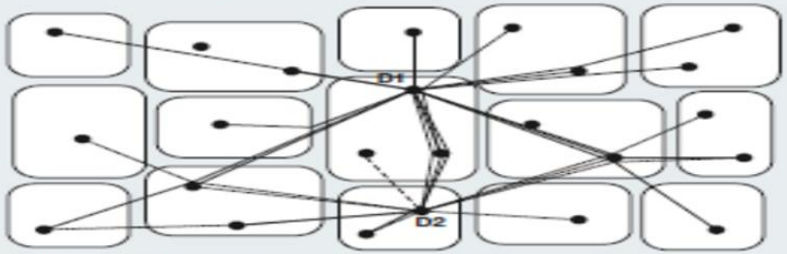


● Main origin or destination

Step 2: Connect the destinations to the departure points with elastic threads
(In the figure an example for two destinations)

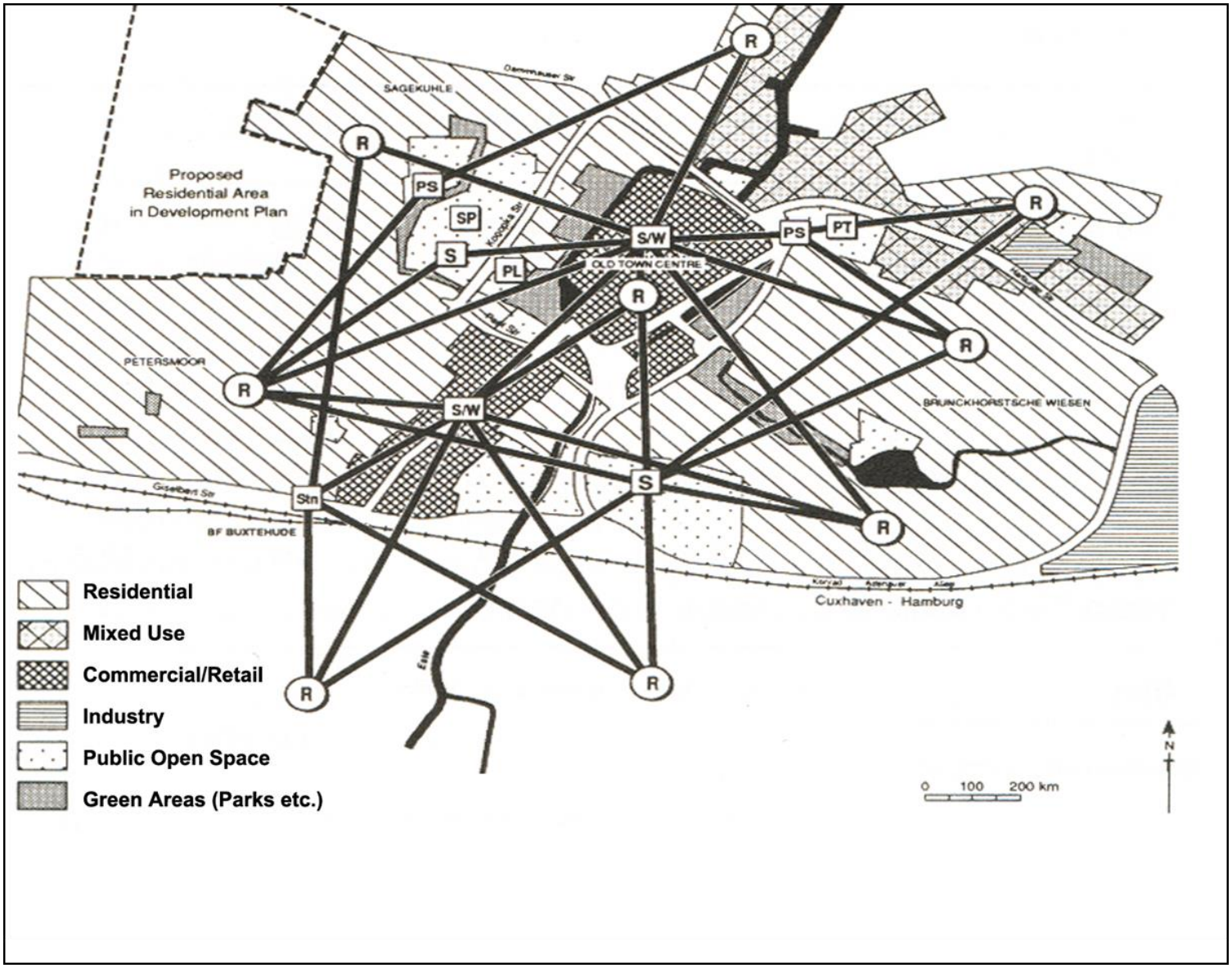
● Main origin or destination

Step 3: Design cycle routes by bundling the elastic threads with pins
(In the figure the threads connected to two destinations are bundled, resulting is several cycle routes. If this is done with more destinations a network of cycle routes can be found.)



● Main origin or destination

Planning Steps in Cycle Route Network Planning (10)

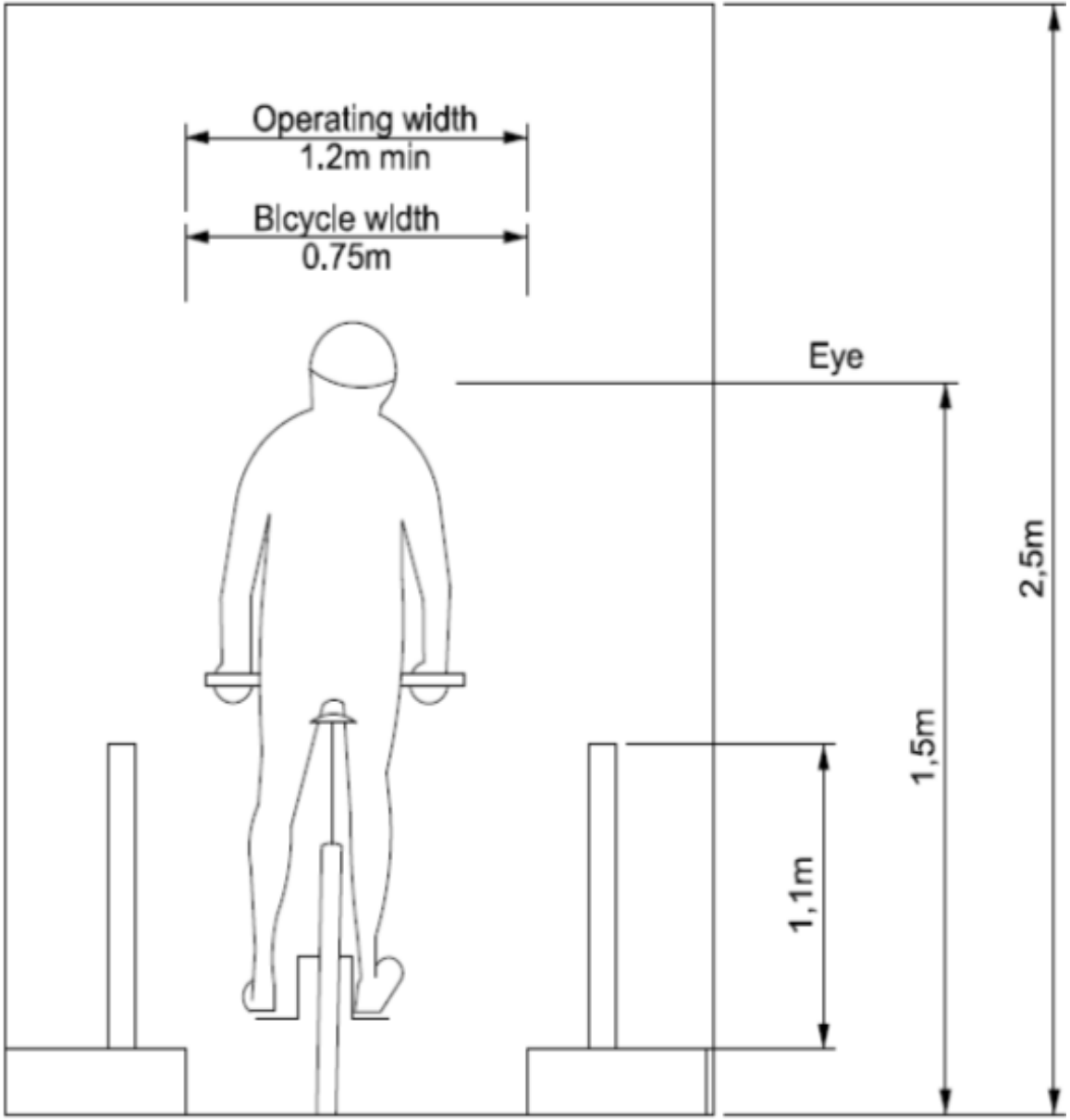


3. Design criteria for cyclists

Design dimension requirements at public transport facilities: Bicycle dimensions

- Various types and sizes of bicycles ranging from smallest bicycle used by young children to the largest cycle used by adults. For design, conservative dimensions which provides for most cyclists.
- The design space for a bicycle are:
  - A clear vertical height of 2,5 m.
  - Under normal conditions, a moving bicycle needs a corridor of at least 1 m wide in order to maintain balance when riding at low speeds. To ride at speed a basic operating width of 1,2 m is required.
  - In enclosed areas, a space of 3 m is desirable for two opposing cyclists to comfortably pass each other. In an open area, slightly less space can be provided.

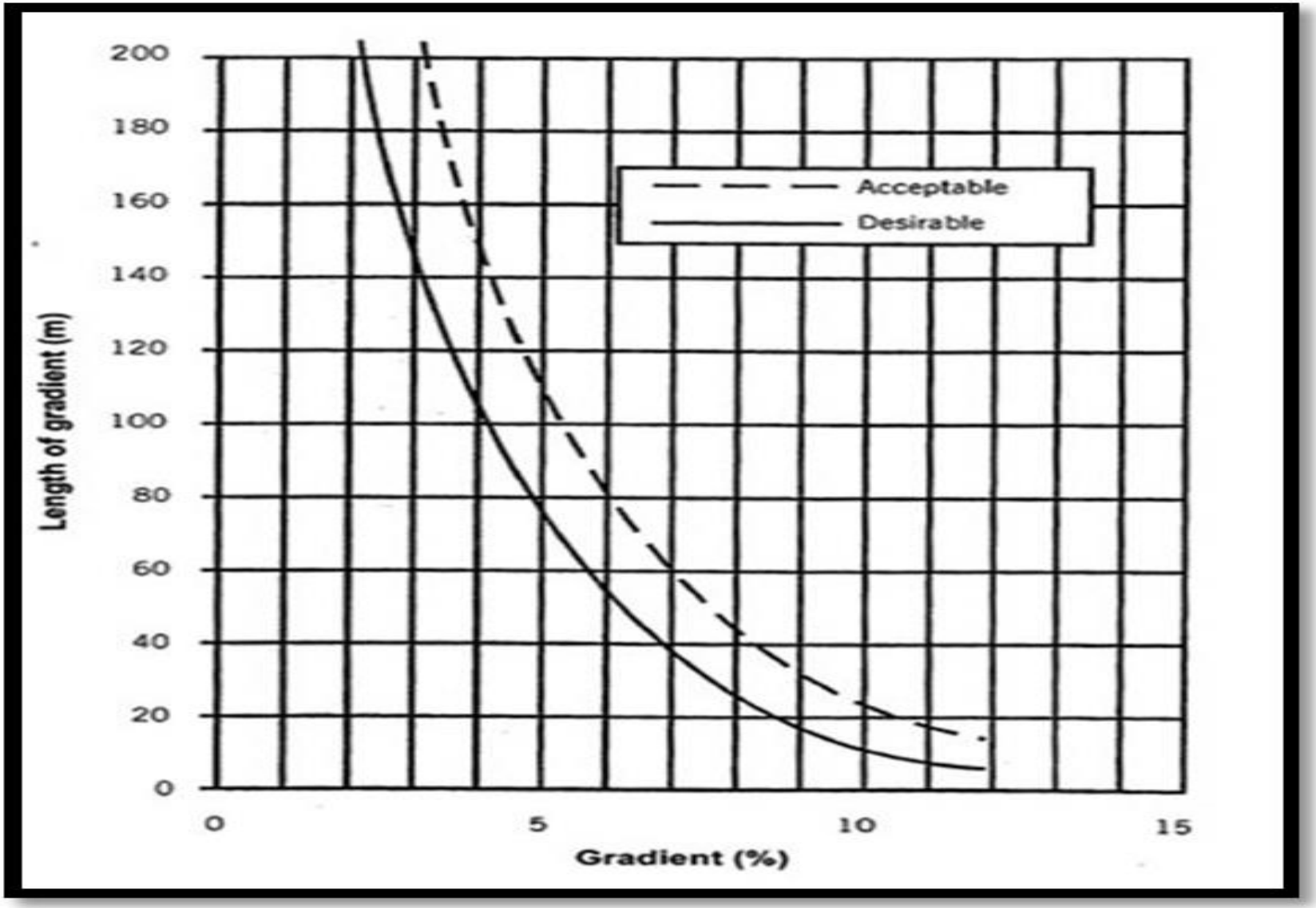
Design dimension for cyclists



Design criteria for cyclists

Parameter	Absolute Minimum	Recommended Minimum	Optimal
Bicycle lane – tot. separation - two way	1.5 m	1.8 m	2.0 m subject to cap requirements
Bicycle lane – part. separation - two way	1.5 m	1.8 m	2.5 m subject to cap requirements
Bicycle lane - marked separation - one way	1.5 m	1.8 m	1.8 m subject to cap requirements
Bicycle lane min radius	3 m	3 m	5 m
Crossfall/Camber	1 : 50	1 : 50	1 : 50
Separation from traffic	120 km/h – 5 m 80 km/h – 2 m 60 km/h – 1 m	120 km/h – 7 m 80 km/h – 3 m 60 km/h – 1 m	120 km/h – 9 m 80 km/h – 4 m 60 km/h – 2 m

Acceptable gradients for cycling (Austroads, 1993)



Sight distance requirements

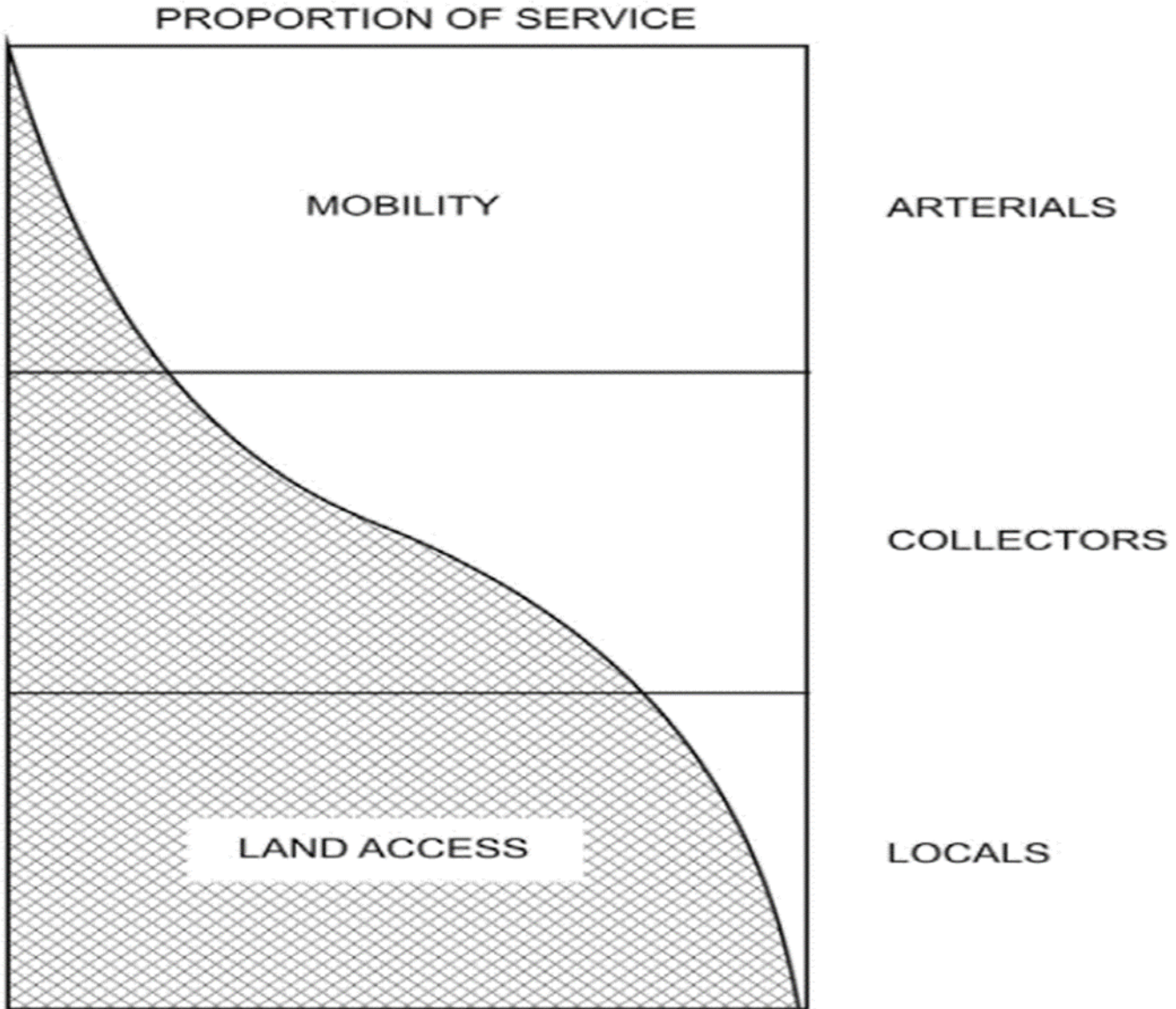
Provision of sight distance is crucial for traffic safety. Sufficient sight distance to be provided for pedestrians and cyclists to view safety hazards and react accordingly. Sight distance requirements considered in design of pedestrian and bicycle facilities:

- ***Stopping sight distances*** required by cyclists to perceive a hazard and to stop safely.
- ***Decision sight distance*** required by cyclists to view their environment and to make decisions.
- ***Gap acceptance sight distance*** required wherever pedestrians and cyclists must cross a road or street by looking for gaps in traffic.

4. Cycle lane design by road class

RSIFSA/COTO (2012 classification of roads)

RELATIONSHIP OF FUNCTIONALLY CLASSIFIED SYSTEMS IN SERVING TRAFFIC MOBILITY AND LAND ACCESS



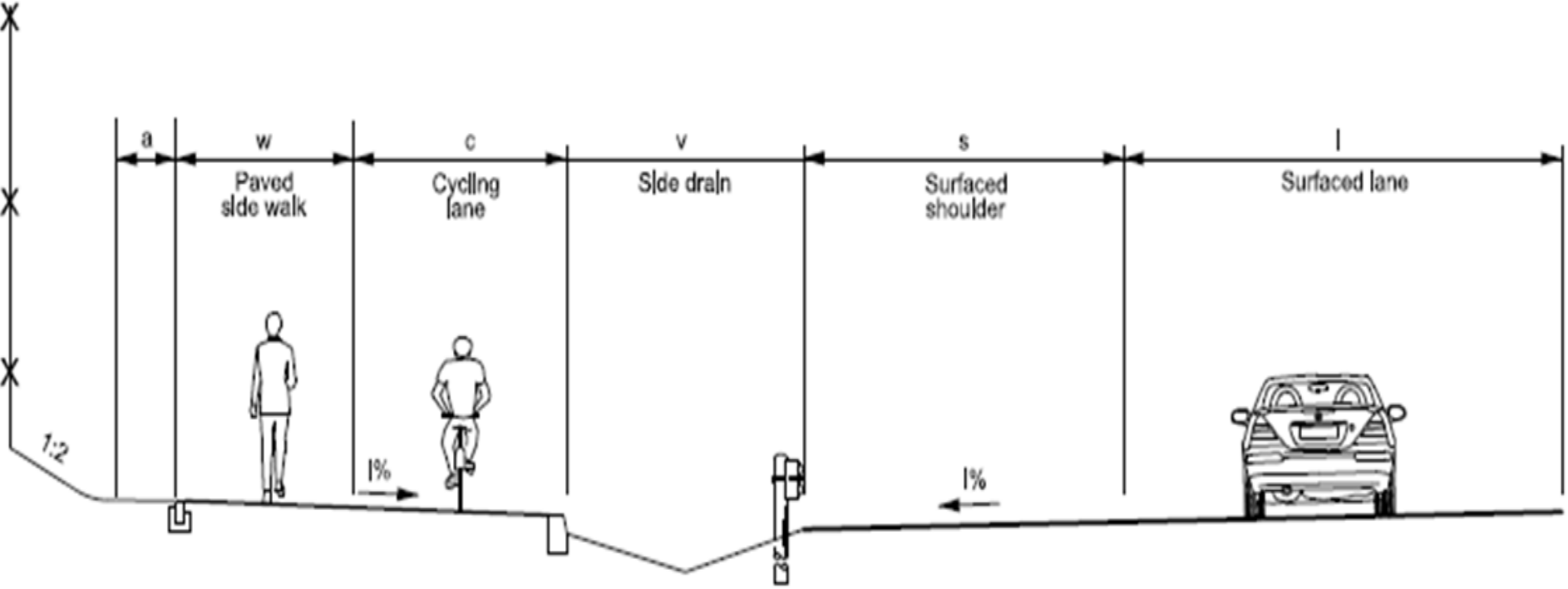
Cycle lanes along roads

RISFSA/COTO (2012 classification of roads)

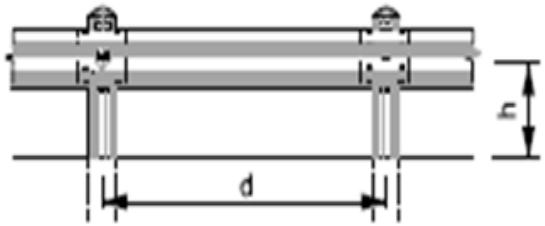
- Freeways with Controlled Access
- High Speed Highways
- Kerbed Arterials
- Urban Distributors and Collectors
- Access Roads
- Bicycle Priority Streets

Cycle lanes along Freeways with Controlled Access

- As a rule, *NMT alongside freeways with controlled access should be avoided,* due to high speeds and the need to prevent people from crossing the road or using the road reserve.
- Adjacent NMT *facility can be considered when no alternatives and NMT facility can be fenced off* from the motorised vehicles in a sustainable manner, while not detracting from safety related to accidental run-off-the road accidents.



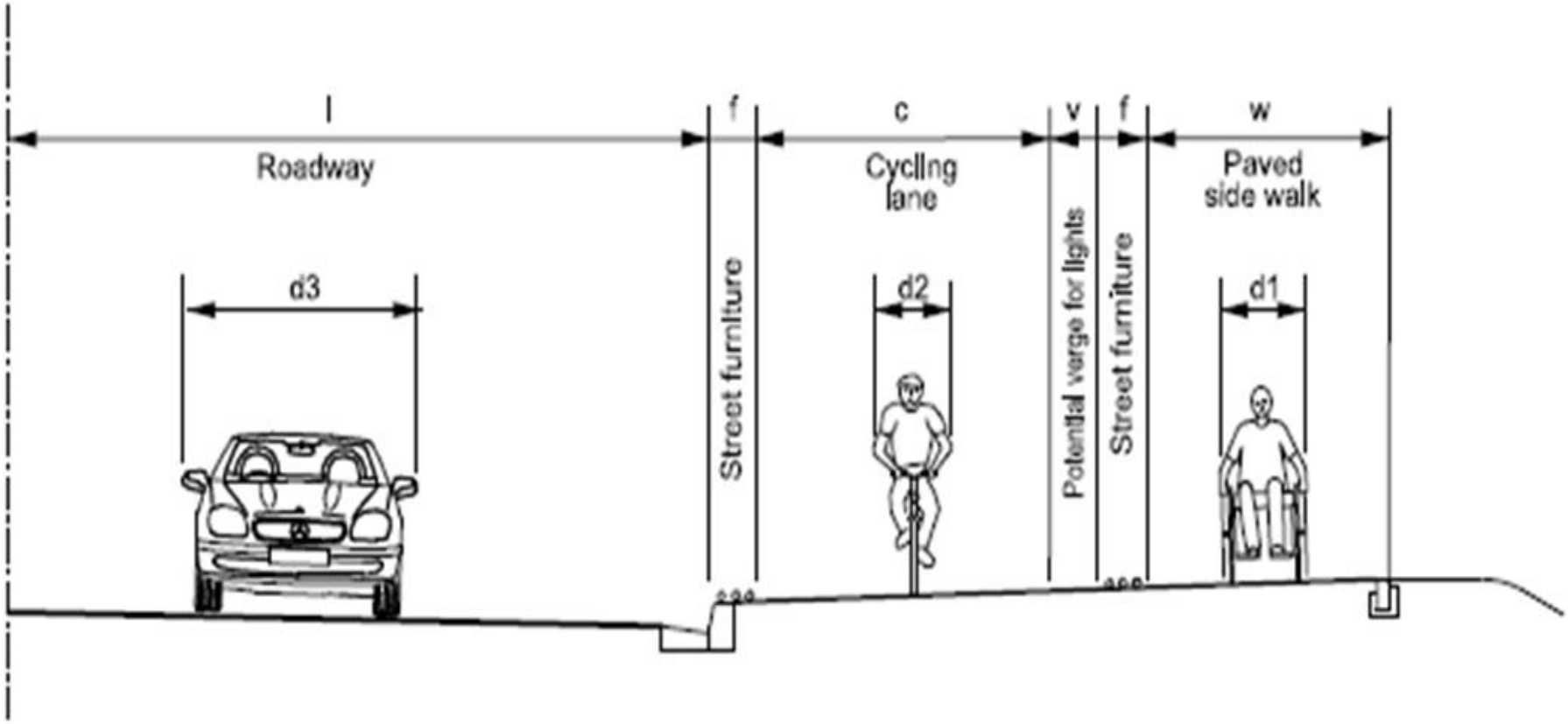
CROSS SECTION



GUARDRAIL : FRONT ELEVATION

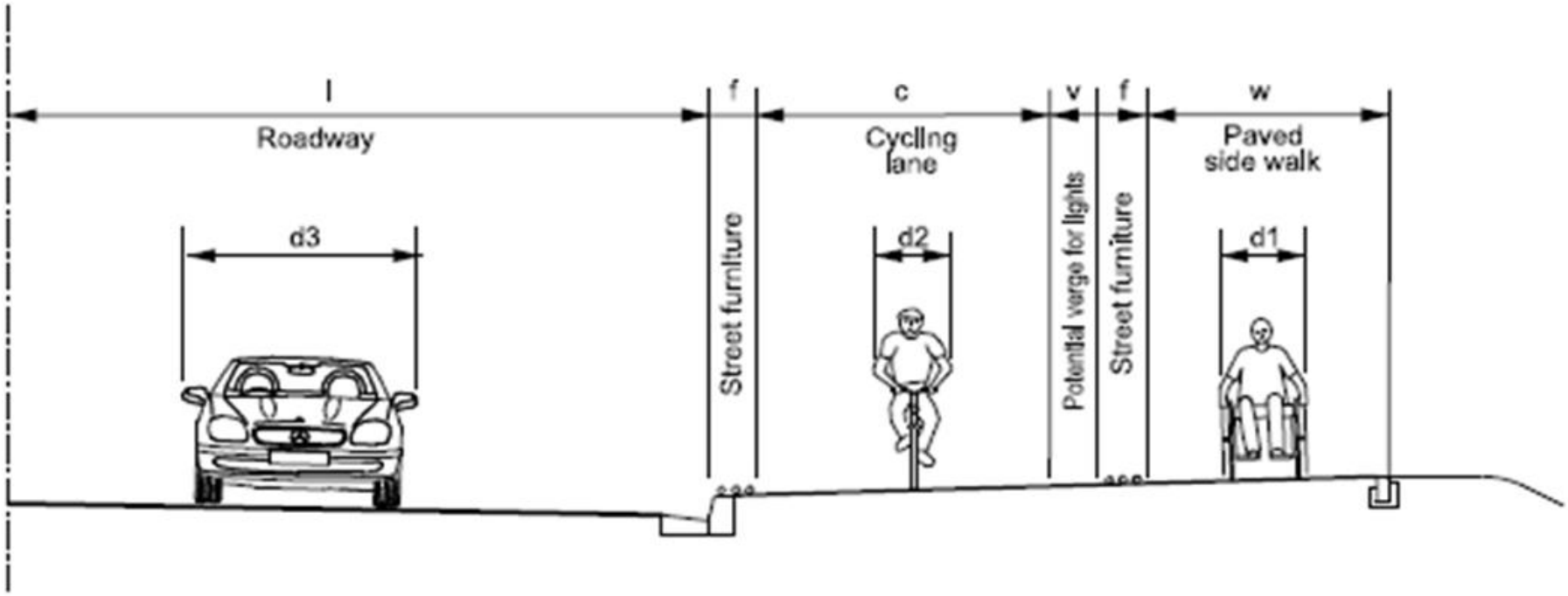
Cycle lanes along High Speed Highways

- Design of highway will normally include the *provision of a forgiving roadside allowing drivers to recover* or avoid serious injury in the event of a run-off-the-road accident.
- *NMT users to be totally separated* preferably from motorised vehicles to prevent serious accidents.
- Can be achieved by *placing the NMT ways at an appropriate distance from the edge of the road or by using a heavy barrier (guardrail)* to provide protection in the event of loss of control.


l
Roadway
f
Street furniture
c
Cycling lane
v
Potential verge for lights
f
Street furniture
w
Paved side walk
d3
d2
d1

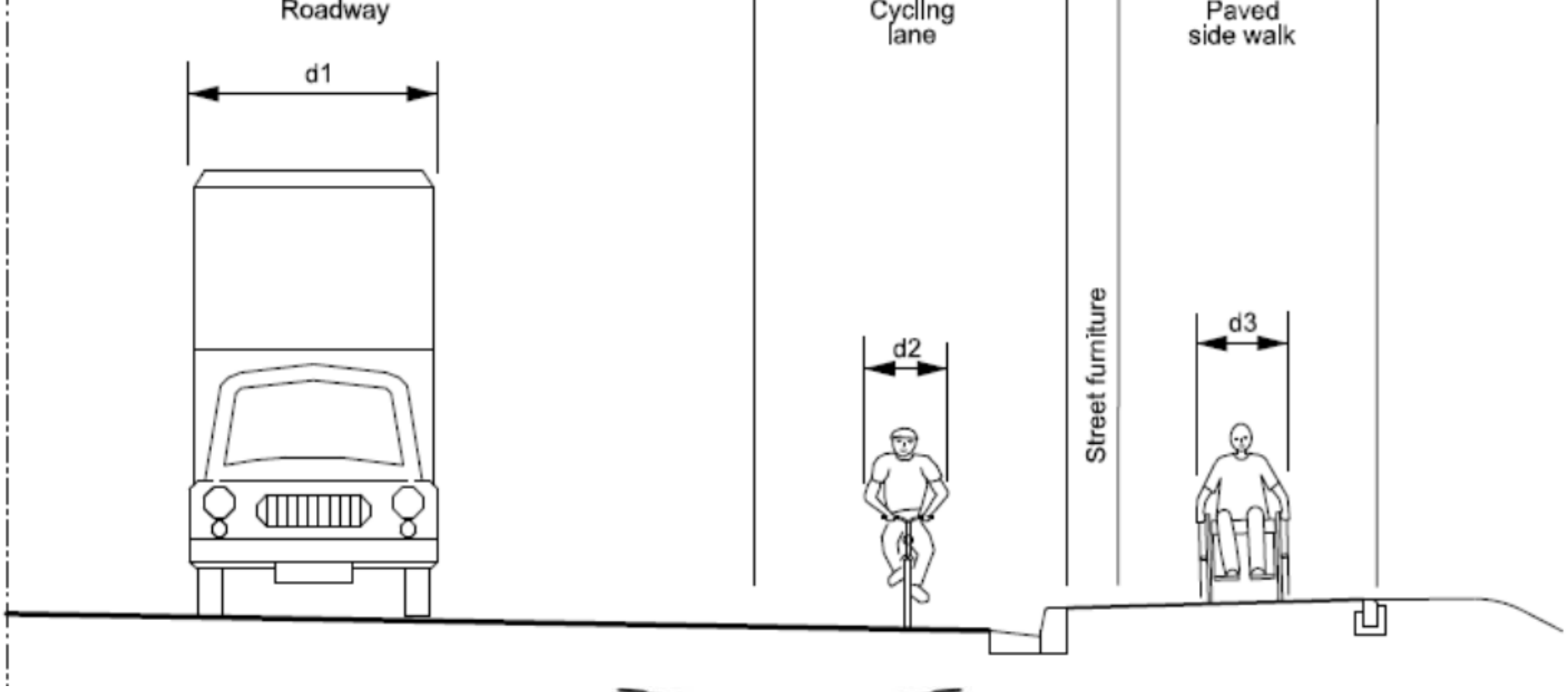
Cycle lanes along Kerbed Arterials

- Slower operating speeds between 60 km/h to 80 km/h and *kerb represents a barrier between vehicles and NMT users*.
- Normal to place the *bicycle lane adjacent to the kerb and the pedestrian walkway just outside the bicycle lane*.
- In some circumstances where the sidewalks and narrow and cannot accommodate bicycle lane, the bicycle lane is placed on the same surface as the motorised traffic and partial separation is effected by a barrier.


l
Roadway
f
Street furniture
c
Cycling lane
v
Potential verge for lights
f
Street furniture
w
Paved side walk
d3
d2
d1

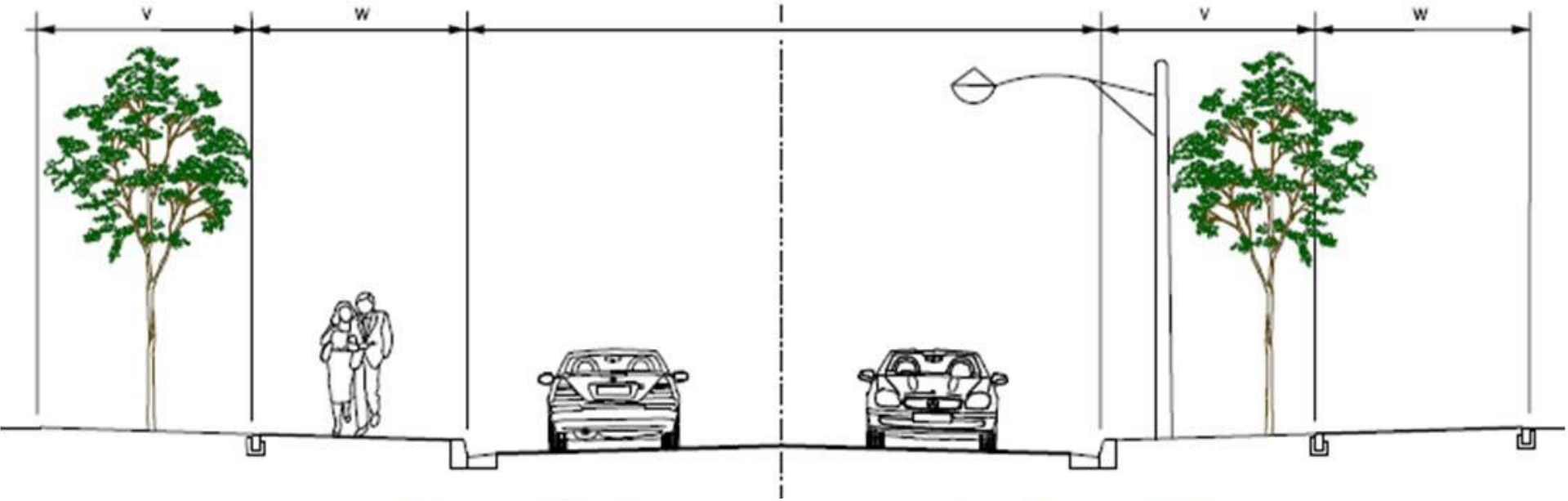
Cycle lanes along Urban Distributors and Collectors

- On urban collector with bicycle lanes, the bicycle lane is placed on the road surface and is only separated by road markings and signage.
- Urban distributors and collectors are designed to provide access to urban settlements/suburbs. They connect the accessibility spaces with the mobility network. Their emphasis should be on connectivity and not throughput.


Roadway
d1
Cycling lane
d2
Street furniture
Paved side walk
d3

Cycle lanes along Access Roads

- According to COTO (2012), design speed in urban local access roads is 40 km/h. All design elements (most important is sight distances), are influenced by the design speed, allowing faster speeds than design speed, can result in a road safety risk.
- Design of access road should focus on the creation of pedestrian and bicycle-friendly environments, keeping the overall aim of ‘access for all’ in mind. Careful planning of various design elements, including parking, is required.


v
w
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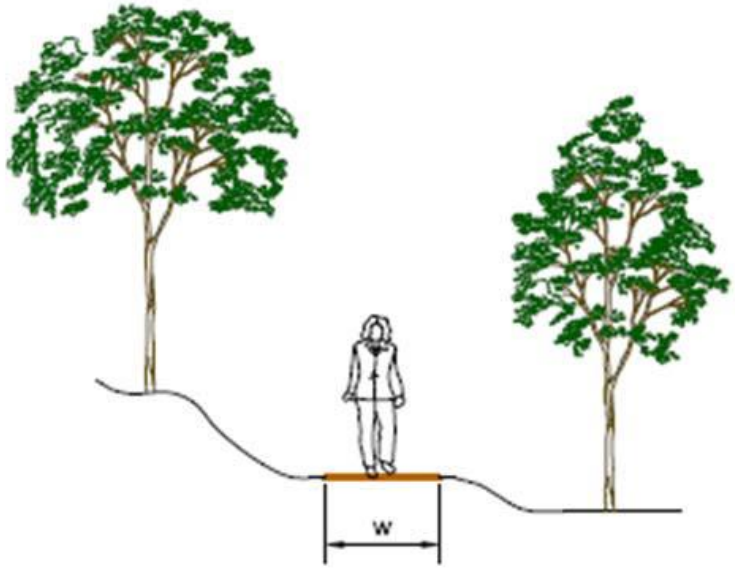
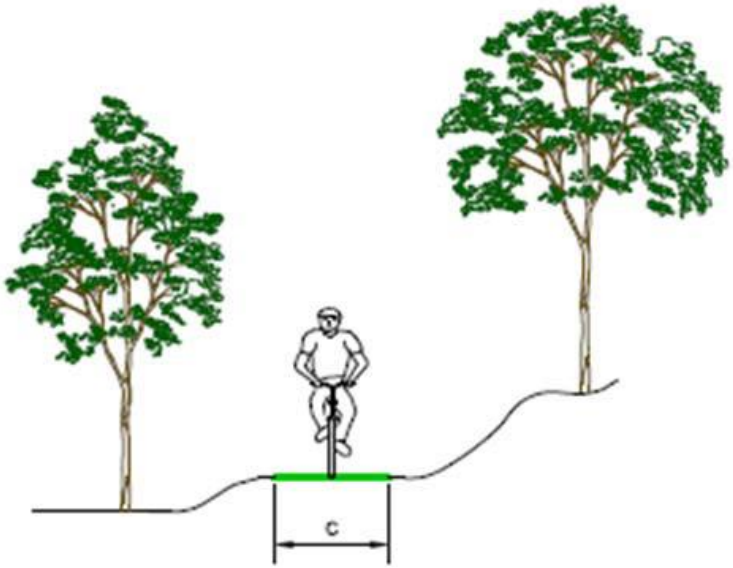
Cycle facilities through open space





Bicycle Priority Streets

- Bicycle priority streets in urban areas are used to maintain continuity of bicycle routes where this is not possible alongside collectors or arterials due to inadequate space at major intersections or the like.
- In this event a short section of access road is designated and signed as a bicycle priority street and bicycles have right of way over motorised vehicles. The speed limit on the street is reduced to 25 km/h and motorists may not overtake bicycles.

Bicycle priority street - London

Bicycle priority street – London (Example of a Road Diet)

5. Design of cycle crossings

Cycle crossings

- Bridges and subways (Grade separated crossings)
- At-grade cycle crossing facilities
- Rail crossings

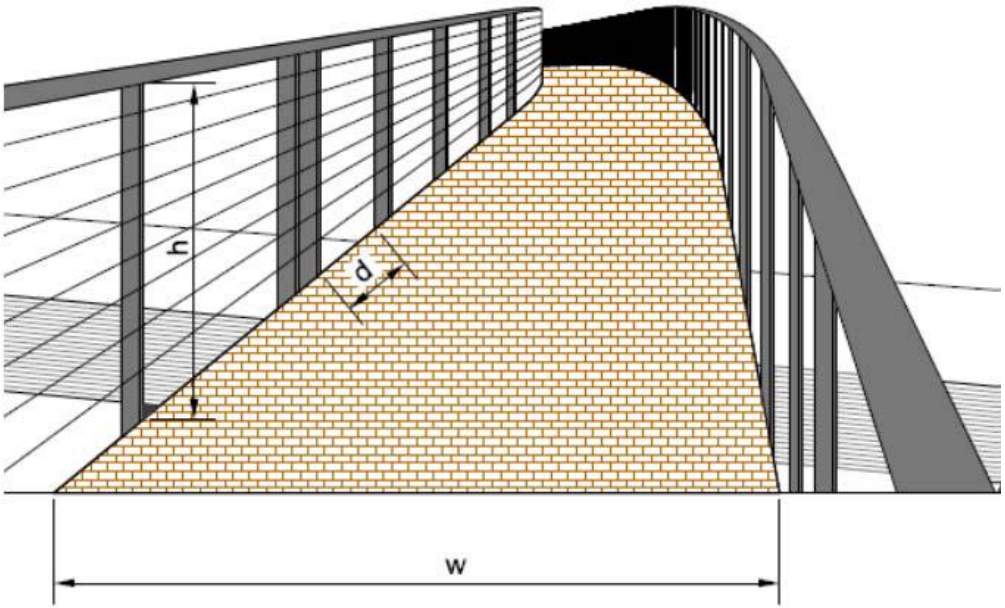
Bridges and subways

- Bridges can be used to provide safe crossing facilities when at-grade crossing is forbidden or deemed too dangerous.
- A serious concern regarding bridges is the total metres that need to be overcome while ‘climbing’ a bridge. In urban areas, the distance is typically 5 m. NMT bridges on highways, typically add a meter, i.e. have a 6 m height difference.
- **Principles:**
  - Width needs to accommodate at least two persons with wheelchairs/prams passing.
  - Cyclists will also need to use these facilities.

Bridges and subways

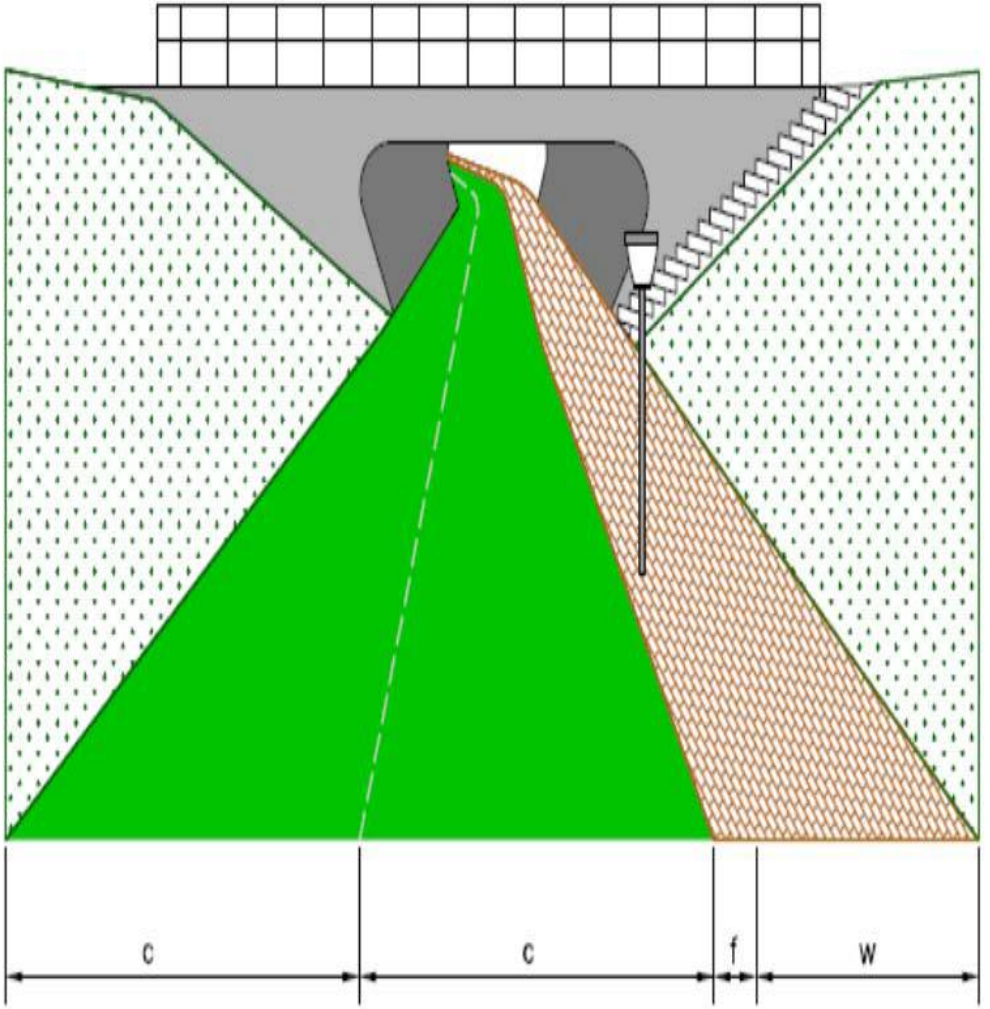
- **Positive Aspects:**
  - Safety for all modes of transport is guaranteed.
- **Negative Aspects:**
  - Construction is expensive.
  - Security can become an issue (width, lighting, etc.)
  - People need to be encouraged to use the facilities; otherwise, it will only create a road safety burden if these facilities are in an inconvenient location.

Bridges and subways

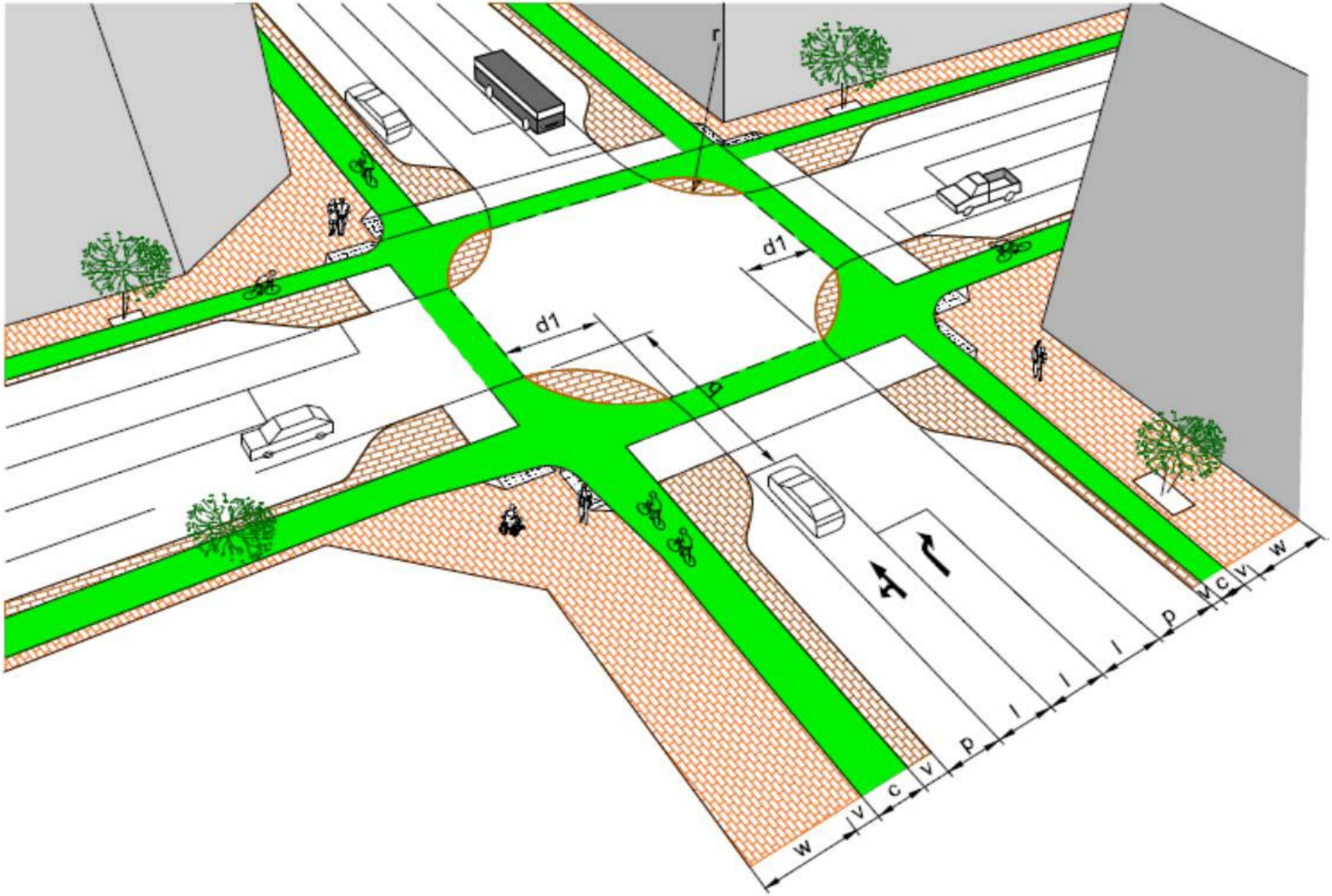


Bridges and subways

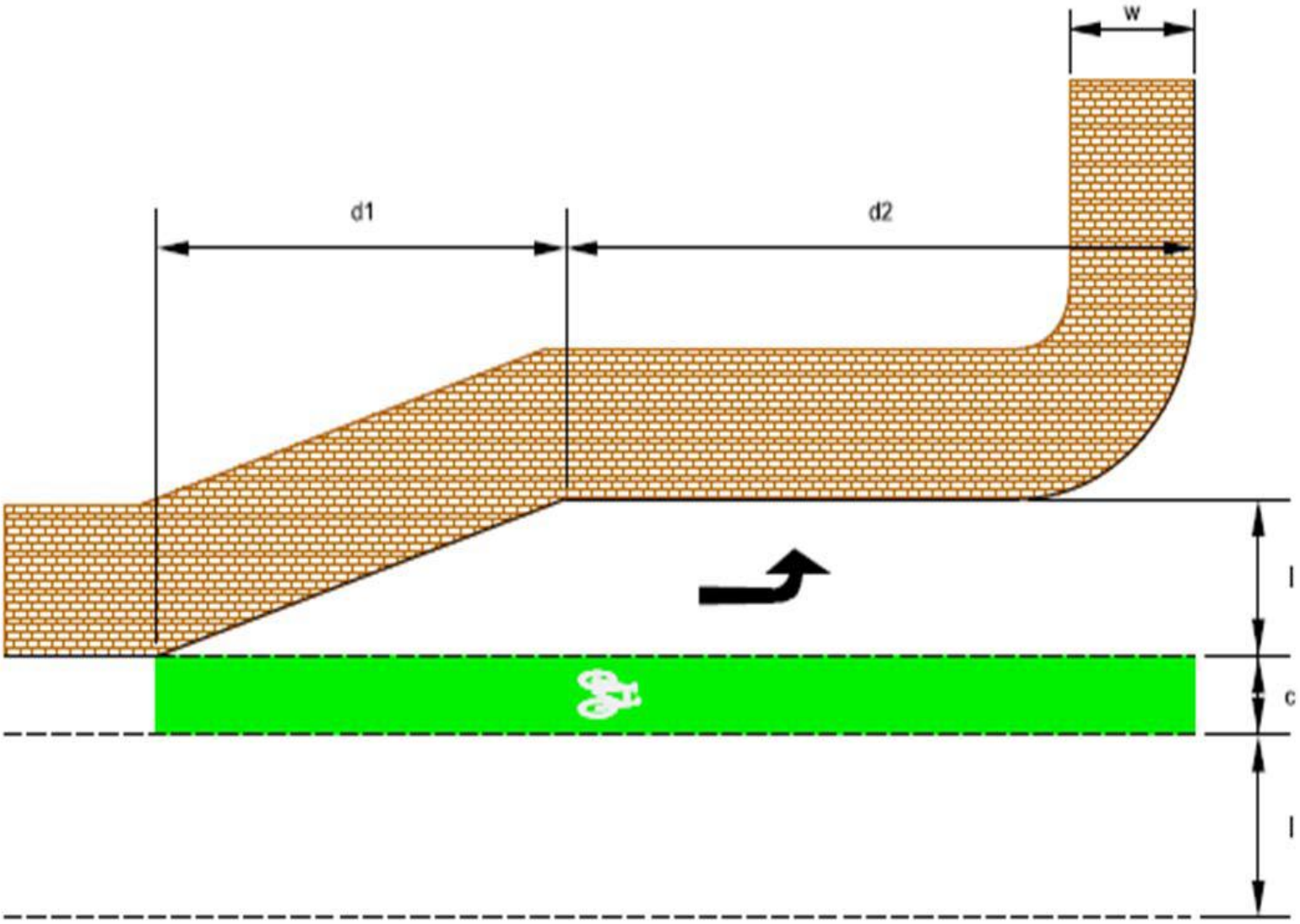
Bridges and subways



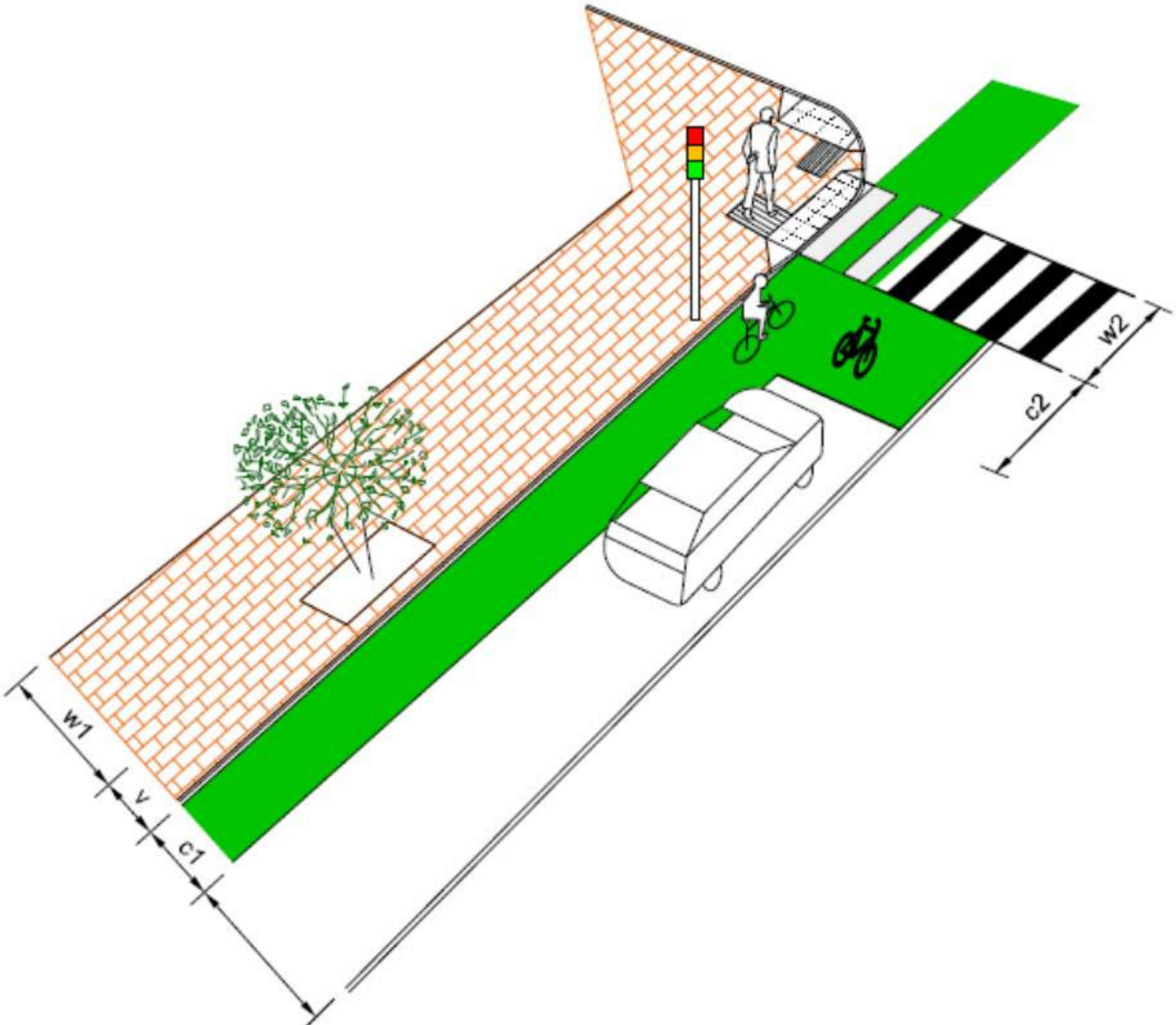
At-grade Cycle Facilities



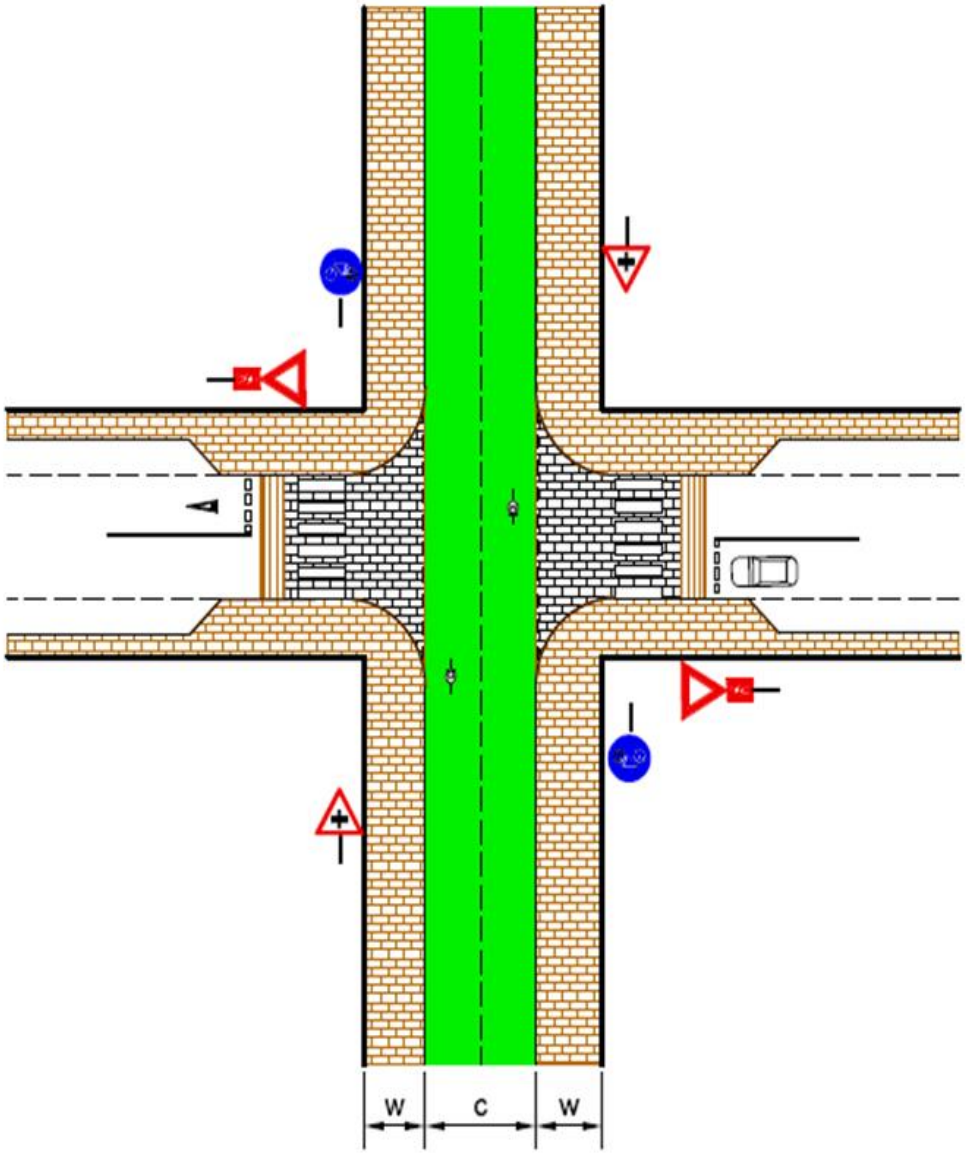
At-grade Cycle Facilities



At-grade Cycle Turning Facilities



At-grade Midblock Cycle Crossing Facilities



RFID Tags Allow Danish Cyclists To Turn Traffic Lights Green

As cyclists approach a junction, the tag sends a signal to a nearby reader, which in turn switches the light to green.
file:///D:/RFID%20Tags%20Allow%20Danish%20Cyclists%20To%20Turn%20Traffic%20Lights%20Green.html

Bike priority in Rotterdam when raining

The Yellow Jacket

Rail crossings and cycling

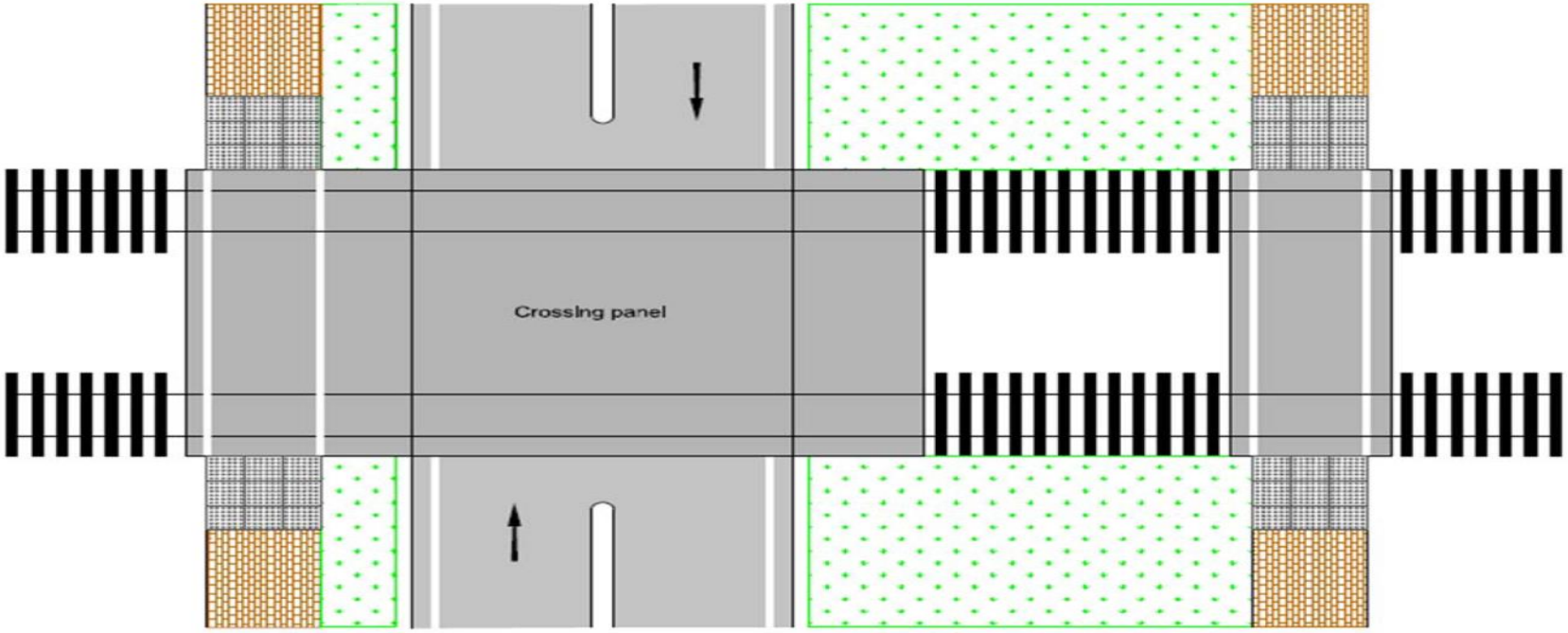
- Intersections with railway come with a safety risk for motorised transport, as well as NMT users such as cyclists and pedestrians.
- Trains have right of way at any intersection and given the high speeds that trains travel at, sight distances for other road users are often not sufficient, and physically impossible to create.
- Railway crossings can be controlled and uncontrolled. Given the vast amount of accidents, controlled intersections or grade separation are recommended.

Rail crossings and cycling

Current Rail Signals: SARTSM - Chapter 14

Train coming

No train



Rail crossings and cycling

6. Traffic Calming and Cycling

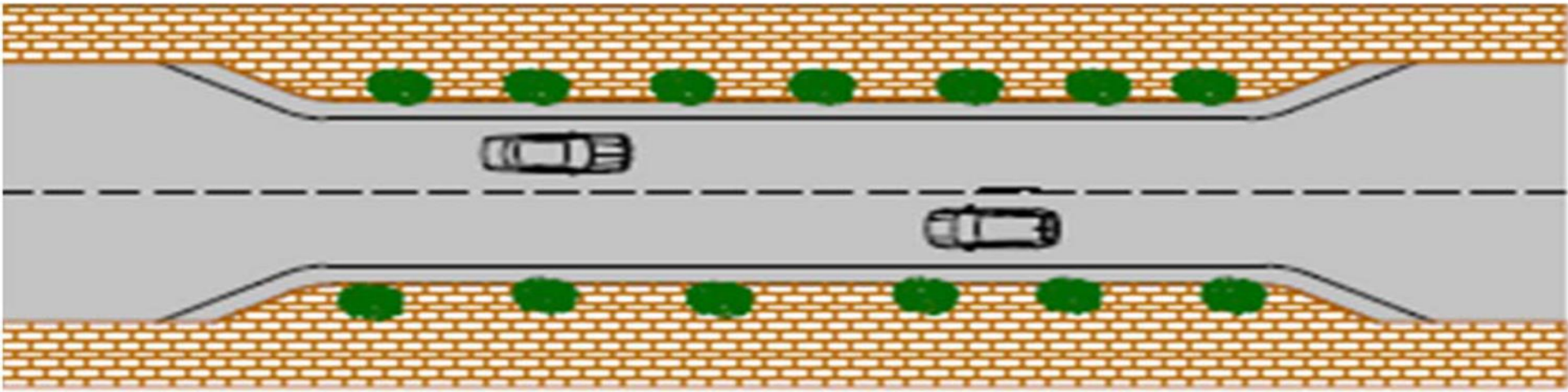
Traffic calming and cycling

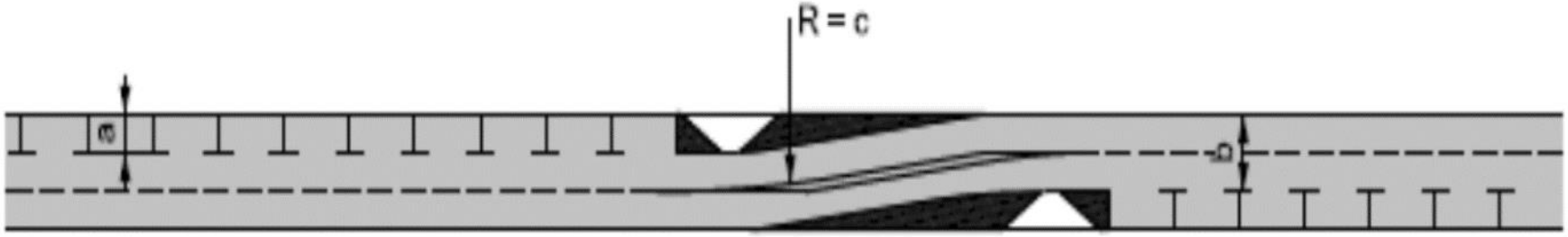
- Speed hump/table *
- Raised crosswalk *
- Raised intersection
- Textured pavements
- Rumble strips*
- Traffic (mini) circle*
- Roundabout*
- Chicanes*
- Realigned intersection*
- Neck downs*
- Centre island narrowing*
- Chokers*
- ‘Road diets’*
- Full closure +
- Half closure +
- Diagonal diverters +

* Could be hazardous for cyclists if not properly designed

\+ Beneficial to cyclists

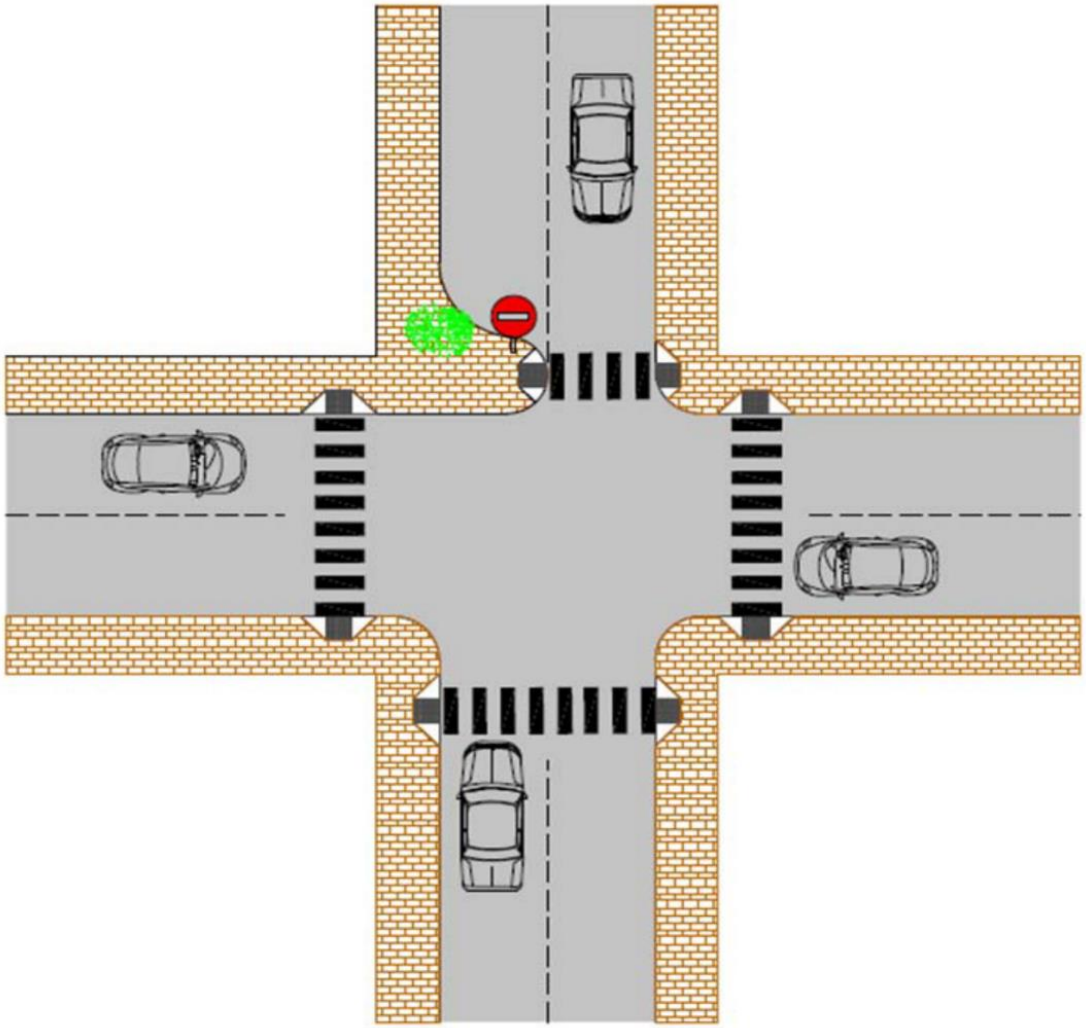
Traffic calming and cycling (Hazardous)





TRAFFIC CALMING AND CYCLING (BENEFICIAL)

Partial or full road closures



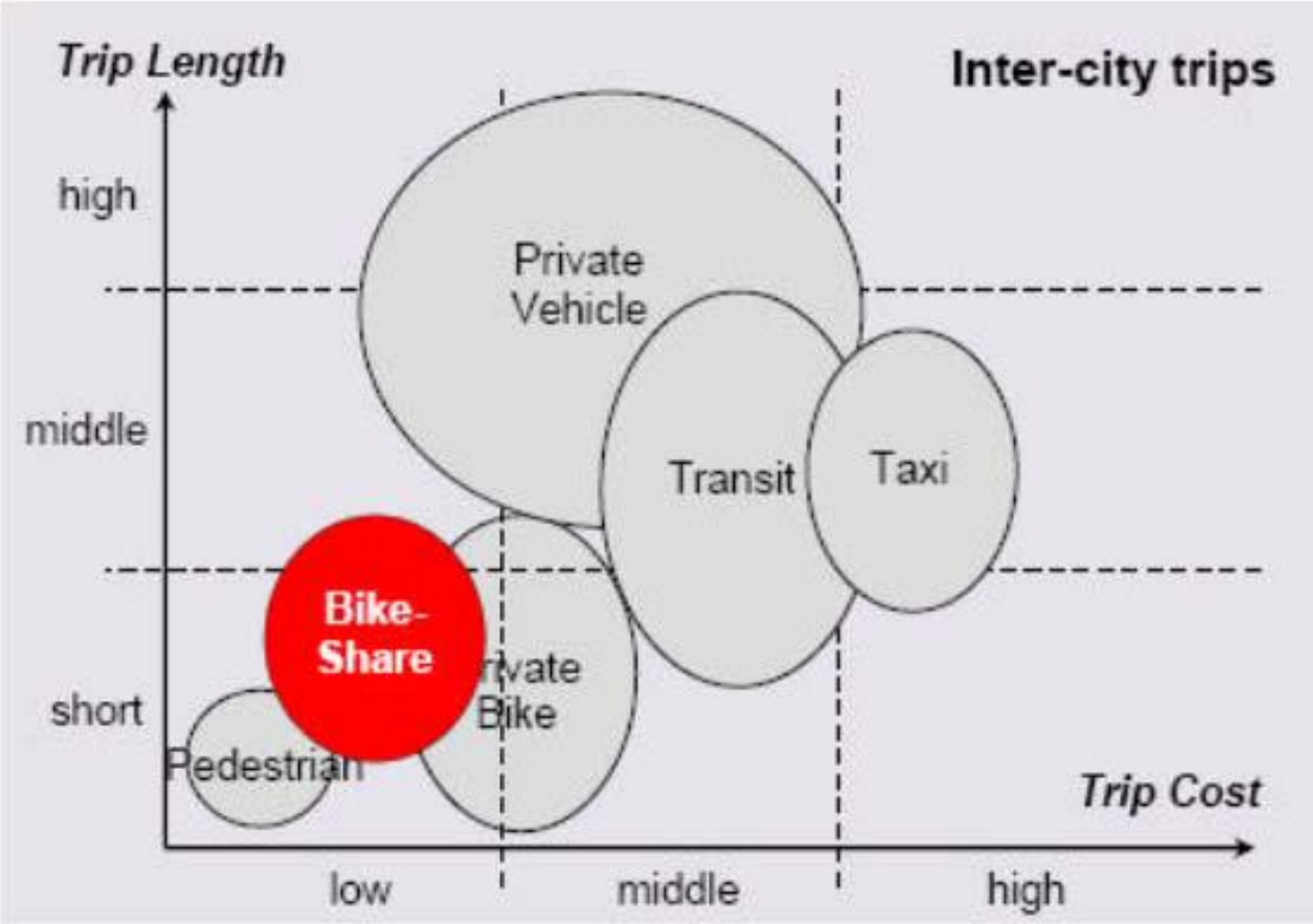
7. Road signage and markings for cycling

Road signage and markings for cycling

RTM 9 Lines Delineating Bicycle Lane

8. Bicycle parking/cycle rental design

Bicycle rental scheme design



Bicycle rental scheme design

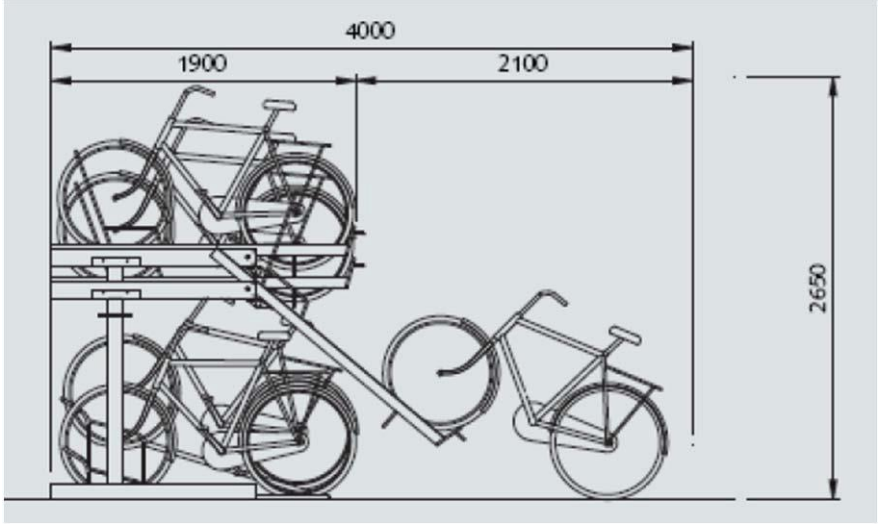
JCDecaux

velib'
MAIRIE DE PARIS
JCDecaux
Cyclocity
JCDecaux
Cyclocity

Bicycle rental system considerations (see Session 10)

- Cycling infrastructure, including parking
- Type of bicycle rental scheme systems
- IT support programs
- Collection and drop-off points – fixed or geo-fencing
- Information and recommended routes
- Barriers to bicycle rental schemes
- Managing and funding+ bicycle rental schemes

Bicycle parking



Bicycle parking design considerations

- Bicycle racks should be permanently affixed to a paved surface.
- Parking facilities should not obstruct the pedestrian walkways.
- Should be easy to find and as close to destinations as practicable.
- Should be fit for purpose and easy to use.
- Stands should have sufficient space around them to ensure they are convenient to gain access.
- Public transport interchanges, places popular with tourists be provided with bicycle parking facilities appropriate to demand.
- Long-term parking for regular users should ideally be within a secure access area and protected from the weather.

9. Pavement design for cycle routes

Pavement design for cycle routes (see Session 14)

Surface finishes and the underlying pavement are important in creating appropriate NMT mobility routes and access to services. Requirements for NMT surfaces include:

- Smooth and even surfaces
- Stable pavement structures
- Sufficient surface friction/traction
- Obstruction free
- Well drained
- Appropriate sight lines with clear signage and road furniture
- A welcoming ambiance.