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Pedagogical course handout

ROADS AND MISCELLANEOUS NETWORKS

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For students of
3rd year Bachelor of Civil Engineering



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Preamble

Roadworks are at the heart of urban and rural development, playing a key role in the structuring of public spaces and the management of infrastructures essential to quality of life. It covers a wide range of works and structures designed to ensure the mobility, safety, comfort and environmental integration of landscaped areas.

This course provides a comprehensive introduction to roadworks, focusing on the fundamental principles, methods, materials and standards governing their design, implementation and maintenance. The aim is to equip Civil Engineering students with the skills needed to design and build projects adapted to modern functional, aesthetic and environmental requirements.

The handbook is structured around the following four chapters:

Chapter 1: Roadworks

In this chapter, students will learn to define and classify the different types of roadway. They will explore the essential characteristics of roadways, including the layout of lanes and the composition of pavements (with a focus on the different constituent layers). Specific themes will be addressed, such as :

- Parking areas (sidewalks, pedestrian walkways, kerbs);
- Integration of disabled people into urban planning;
- Lanes reserved for emergency vehicles, vehicle lanes and ladder lanes.

Chapter 2: Sewerage

This chapter deals with sewerage systems and their importance in water evacuation and management. Topics covered include :

- The different types of water to be evacuated (rainwater, runoff, domestic wastewater, industrial wastewater);

- Pipe sizing and network composition (collectors, pipes, manholes, inspection shafts, connections);

- Specific structures, such as storm drains, runoff collection structures and ancillary structures.

Chapter 3: Miscellaneous networks

This chapter focuses on the various networks essential to the operation of urban areas:

- Drinking water supply networks, including water requirements, distribution network (types and materials), connections, service and fire reserves;

- Electricity, fuel gas and telecommunications distribution networks.

Chapter 4: Green spaces

The design and management of green spaces play a crucial role in urban planning. This chapter explores :

- Principles of green space design;

- The different components of green spaces;

- Management methods to ensure their sustainability and attractiveness.

This handbook provides a solid foundation for understanding and mastering the technical and practical issues involved in roadworks. It aims to prepare students to meet the challenges of modern landscaping and to integrate best practices into their future professional projects.

Summary

This academic handout on *Roads and Miscellaneous Networks (VRD)* is designed for third-year undergraduate students in Civil Engineering. It offers a comprehensive overview of the technical principles involved in the planning, design, and implementation of urban and rural infrastructure systems. Core topics include roadway design and classification, drainage and sewerage networks, utility distribution systems (water, electricity, telecommunications), and the integration of green spaces. Emphasis is placed on national and international standards, user safety, universal accessibility, and sustainable development practices in infrastructure engineering.

Keywords: Roads, Miscellaneous Networks, Drainage, Geometric design, Landscaping of green spaces

Résumé

Ce polycopié pédagogique sur les *Voiries et Réseaux Divers (VRD)* est destiné aux étudiants de troisième année Licence en Génie Civil. Il propose une vue d'ensemble structurée des principes techniques régissant la conception, la planification et la mise en œuvre des infrastructures urbaines et rurales. Les thèmes abordés incluent la classification et la conception géométrique des voiries, les réseaux d'assainissement, les systèmes de distribution d'eau, d'électricité, de télécommunications, ainsi que l'aménagement des espaces verts. Une attention particulière est portée aux normes nationales et internationales, à la sécurité des usagers, à l'accessibilité universelle et aux pratiques durables dans l'ingénierie des infrastructures.

Les mots clés : Voiries, réseaux divers, Assainissement, Conception géométrique, Aménagement des espaces verts

المخلص

يُقدم هذا المقرّر البيداغوجي حول " الطرقات والشبكات المختلفة " والموجه لطلبة السنة الثالثة ليسانس في الهندسة المدنية عرضاً شاملاً ومنهجياً للمبادئ التقنية الأساسية التي تدخل في تخطيط وتصميم وتنفيذ البنى التحتية في المناطق الحضرية والريفية. وتشمل المحاور الرئيسية تصميم وتصنيف الطرق، شبكات الصرف الصحي، شبكات توزيع المياه والكهرباء والاتصالات، بالإضافة إلى تنسيق وتهئية المساحات الخضراء. ويركّز هذا المقرّر على أهمية احترام المعايير الوطنية والدولية، وضمان سلامة المستخدمين، و توفير سبل الوصول للجميع، مع تعزيز مبادئ التنمية المستدامة في مشاريع الهندسة المدنية .

الكلمات المفتاحية: الطرق والشبكات المختلفة، الصرف الصحي، التصميم الهندسي، تخطيط المساحات الخضراء

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CHAPTER I

Roadworks

I.1 INTRODUCTION

Roadworks include all structures used by all types of vehicles (cars, trucks, public transport), two-wheelers and pedestrians, as well as parking areas. Roads can be subject to two distinct statuses:

- Public roads are those built and maintained by the state or local authorities;
- Private roads are those built and maintained by private organizations or individuals.

I.2 ROAD CLASSIFICATION

The tracks are classified according to three criteria:

a) the traffic they receive: it has a direct influence on the design of the pavement and its foundation. It is characterized by its nature and importance. By convention, it is accepted that the annual average daily traffic (MJA) is determined by the equivalence to a number of heavy goods vehicles.

b) the extent of the areas served: The road network is more or less important depending on the spaces it serves. This results in a hierarchy of routes that are designed accordingly.

c) the typology: The typology of the tracks takes into account essentially their geometric characteristics: configuration, width of the roadways, central ground, presence of sidewalks, parking strips etc

There are three types of road:

- **Primary roadway:** This roadway is designed for general traffic to link any given urban area to a neighboring town. It collects the area's traffic and evacuates it to larger roads. The reference speed is over 80 km/h.

- **Secondary roads:** These link primary and tertiary roads, and carry traffic between neighborhoods. The reference speed is around 50 to 60 Km/h.

- **Tertiary roadway:** This roadway distributes traffic between housing groups, neighborhood units and residential blocks. The reference speed is 20 to 40 Km/h.

1.3 ROAD FEATURES

Roads contribute to the layout and appearance of urban and rural landscapes. Whether straight or curved, they are designed according to the layout of the lots and buildings to which they give access, whether they border the road or are set back from it.

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A specific study is carried out to define the type and flow of traffic that the planned roadway will carry in the area it will serve. Depending on the case, traffic may be :

- Mainly light vehicles
- Mainly heavy goods vehicles;
- Mixed traffic made up of light vehicles, two-wheelers and pedestrians;
- Mainly two-wheelers or pedestrians.

The technical characteristics of the road are specified according to the results of the study and the location: the layout, the width, the presence or absence of sidewalks, the presence or absence of parking along the roadway, the longitudinal section with slopes and run-off collection points, the cross-section with cross slopes, the mechanical characteristics of the roadway and its position, as well as the qualities of the subgrade and surfacing.

Defining the characteristics of a road means designing the three simple geometric elements that make it up:

- The plan, the projection of the road on a horizontal plane.(figure 1.1)

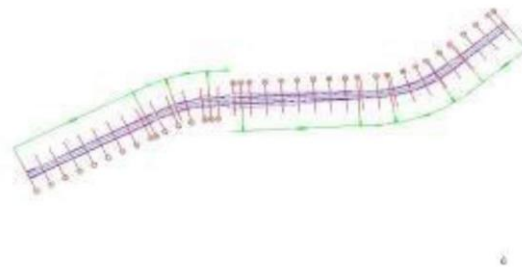


Figure 1.1: horizontal alignment

- Longitudinal profile: development of the intersection of the road surface with the vertical-generating cylinder passing through its axis.(figure 1.2)

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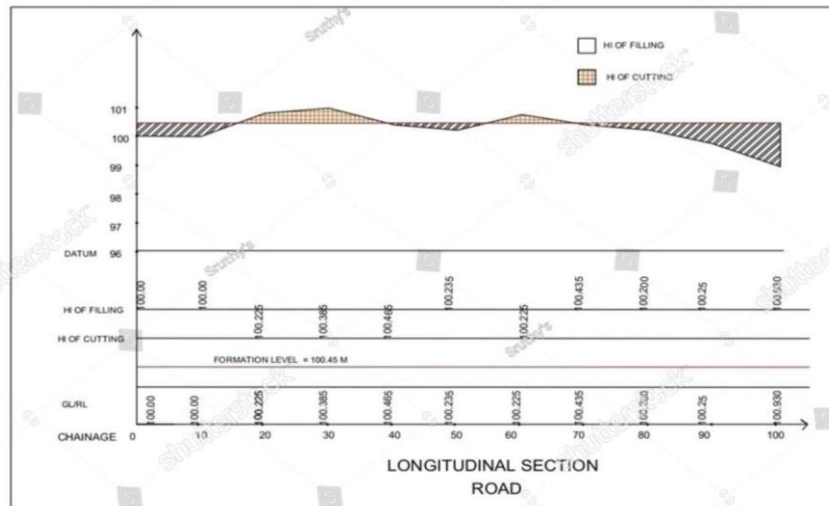


Figure I.2: Longitudinal section road

- The cross-section, cut along a vertical plane perpendicular to the axis.(figure 1.3)

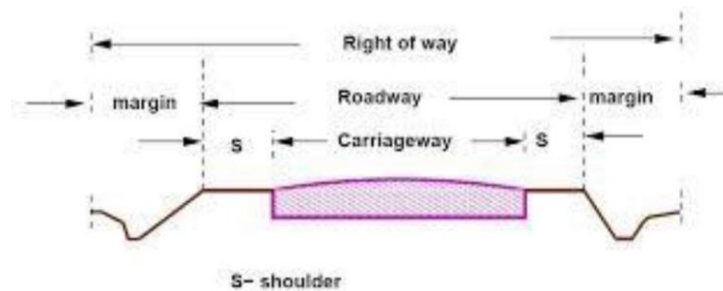


Figure 1.3: Typical cross-section

The standards set out the rules for the design and construction of these three elements.

The requirements that have prevailed in drawing up these standards are twofold: user safety and the ability of the infrastructure to handle the traffic it carries.

The technical conditions under which the various roads must be designed, developed and upgraded are set out in several ministerial instructions. They apply according to the type of road in question.

Every country in the world has its own standards, the Algerian standard being B40: technical conditions for road design, October 1977.

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Various other standards are also used in Algeria, the most widely used being French and European standards rather than American ones. Such as :

(I.C.T.A.A.L.) of March 22, 1971, amended on December 22, 2000. This instruction applies to type L roads.

- The technical guide for the design of main roads (A.R.P.). This guide applies to T and R roads. Its application is mandatory for national roads and increasingly systematic for departmental roads.

- Instruction sur l'aménagement des voies rapides urbaines (I.C.T.A.V.R.U.) (instruction on urban expressways)

I.4 THE TRACK LAYOUT

The plan of a road system is the vertical projection of the space occupied by that network on a horizontal plane. This route is composed of a set of straight lines that intersect at certain points called vertices, which give rise to turns and crossroads in the road system. Special treatment of these places is to be considered because these places can cause harm or discomfort and especially the safety of users.

The layout of the tracks is chosen in such a way as to reconcile several imperatives:

- Fit into the general context, in the site, and adapt as best as possible to the natural terrain, in order to avoid significant land movements;
 - To be integrated into the urban fabric where it exists;
 - Fit the mass plan;
 - Ensure the fluidity of the various flows on the distribution routes;
 - Avoid monotony on service lanes, reduce vehicle speed and improve safety for users by creating chicanes or curves, especially when they have multiple functions (car, bicycle and pedestrian);
- Adapt the curve radii to vehicles on the tracks: trucks, buses, light cars, even in case of occasional traffic. When the radius of curvature is small, in the range of 10 to 15 m, it may be necessary to provide an extra width;
 - Create pedestrian lanes or alleys to reduce distances between homes and centres of interest: shops, school groups or others;
 - Provide parking spaces along the roadside or on specific areas, separated from traffic by

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planted areas, the arrangement adopted may be long, heel or spike;

- Allow all users normal accessibility to the tracks, especially for people with motor disabilities and avoid the proliferation of poles or street furniture causing discomfort to users.

The study of the track layout takes into account a number of parameters relating to :

- The geometry of the site;
- The topography of the site;
- The nature of the soil as determined by geotechnical studies;
- The amount of traffic to be carried;
- The sector and the various points served: housing estate, group of apartment buildings, tertiary activity zone, commercial zone, industrial estate, etc;
- The safety of users, by ensuring good visibility, signposting pedestrian passage and circulation, or separating the traffic of different users by creating landscaping along the roadside;
- Connection with the existing road network, taking into account vehicle manoeuvring possibilities and the passage of other users, using a crossroads designed so that the lanes can intersect perpendicularly or at an angle close to 90°. This arrangement has the advantage of meeting the following objectives:
 - Ensure good visibility at the junction;
 - Reduce the length of road crossed by pedestrians, by providing them with dedicated, signposted crossings;
 - Simplify vehicle manoeuvring, which is always tricky at an acute angle.

Crosswalks are either level with the roadway or slightly raised to reduce vehicle speeds and improve user safety. Their width must allow simultaneous two-way traffic (pedestrians, baby carriages, wheelchairs for the disabled, etc.) and be compatible with the flow of traffic.

I.5 ROADWAY COMPOSITION

The composition and dimensions of the roadway, i.e. its thickness, are determined according to the following parameters:

- The quality and bearing capacity of the subgrade;
- The traffic carried by the roadway;
- Frost resistance.

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The roadway is made up of several superimposed layers resulting from excavation or backfill work, and transmitting loads to the supporting soil.

The various layers of a flexible roadway are, starting from the top (Figure 1.4):

- **the surface layer**
- **base course**
- **sub-base layer**
- **underlay**

These different layers may not exist simultaneously in a roadway. While there is always a base layer, there is not always a surface or sub-base layer.

- The main purpose of **the surface layer** is to absorb the high shear forces generated by traffic in the upper part of the roadway.

- **The surface layer** may be single or multiple; in the latter case, the layer in direct contact with the wheels is called the “**wearing course**”, while the other layer or layers are called the “**binder course**”

- The main purpose of the base layer and, if present, **the sub-base layer**, is to resist vertical loads and to distribute the resulting pressures evenly over the ground; together, these layers form the roadway body.

- When the roadway body needs to be protected from certain effects, an additional course, known as **the sub-base**, is placed between it and the ground. The role of this layer may be to :

- prevent clay from rising up into the roadway (**anti-contaminant layer**),
- drain the subgrade (drainage underlay),
- cut off capillary rise (**anti-capillary underlay**),
- combat **frost (anti-frost underlay)**.

The same underlay can play multiple roles.

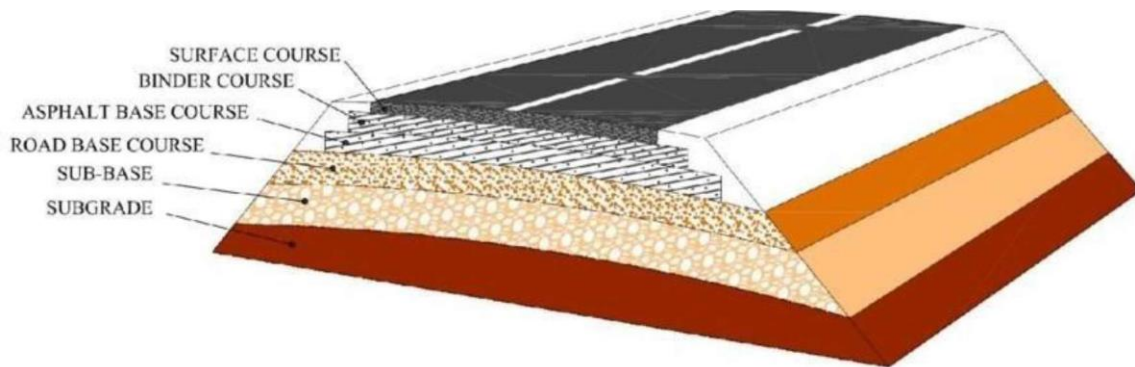


Figure 1.4: Roadway composition

I.6 PARKING LOTS

Parking lots are an essential complement to roads and buildings, whether they are intended for residential, industrial or commercial use. The number of parking spaces is specified in urban planning documents.

A well-designed road network is not only about ensuring that traffic flows smoothly, but also about solving the parking problem, which is particularly acute during peak periods, when the hourly flow of vehicles is very high. To this end, part of the collective space must be set aside for parking needs, because under no circumstances should parking be left to the whim of drivers, as this could compromise the main purpose of the road network, which is to keep traffic flowing smoothly.

I.6.1 PARKING REQUEST:

Two methods can be used to assess demand, based on statistical procedures and surveys that depend on a number of parameters:

- Total population of the urbanized area.
- Motorization rate of the area under consideration.
- Peak hour vehicle rate

I.6.2 PARKING OFFER

Vehicle parking is organized on specially-designed lanes, either on the traffic lane or on the side lane. The following must always be borne in mind when designing a parking lane: - Minimum width, especially for lanes on the roadway (2.5m-5.00m) - If there are no natural

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constraints on the terrain, opt for the most economical arrangement of lanes in terms of surface area. The minimum dimensions of a parking strip are 2.5 m wide and 5 m long.

I.6.3 DIFFERENT TYPES OF PARKING

Main storage modes :

❖ Longitudinal storage :

This storage mode can be used along a lane for a few cars (Figure 1.5)

- Width of storage lane: 2.2m
- Width of manoeuvring lane: 2.50m
- Number of spaces per 100 m length: 16 to 18
- Economical in terms of surface area, it allows the use of narrow lanes.
- Economical for lanes that complement equipment and commercial premises

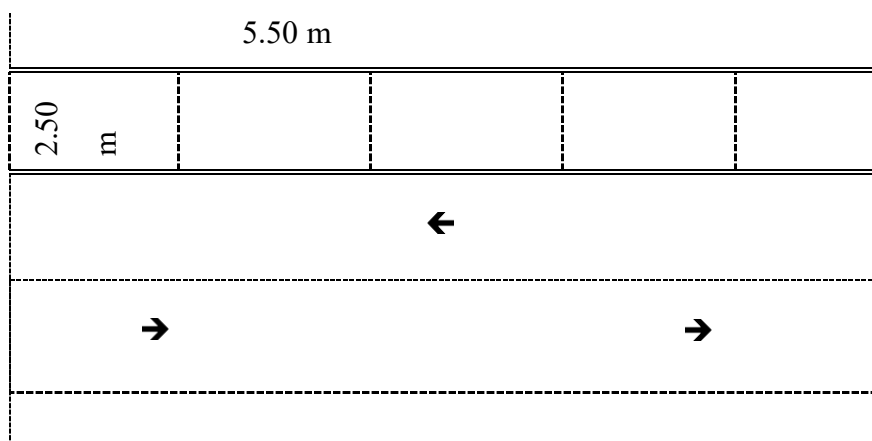


Figure 1.5: Longitudinal storage along a track

❖ 90° storage (or battle-shaped)

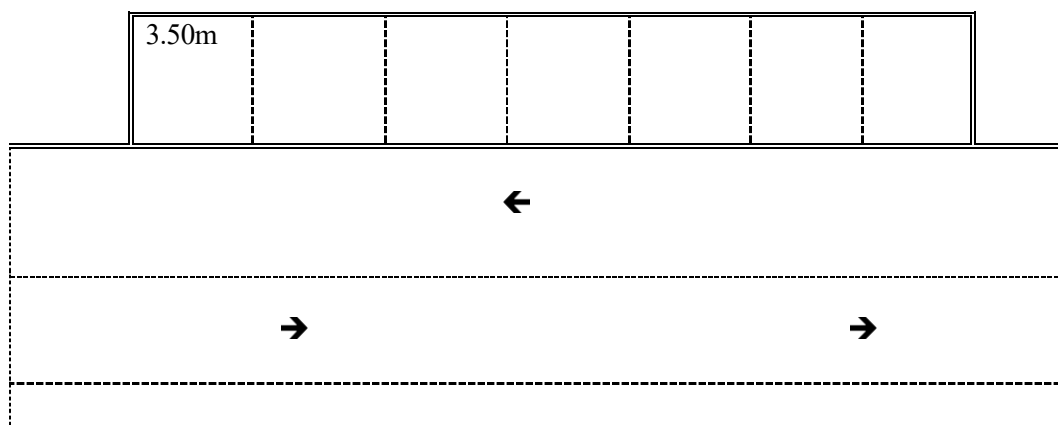


Figure 1.6 : 90° trackside storage

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This is a storage lane that runs perpendicular to the roadway (Figure 1.6).

- Length of parking lane: 5m
- Stowage lane width: 2.50m
- Number of spaces per 100 m: 40

This type of storage is the one that allows the greatest number of cars to be stored on a given length. It is also more economical in terms of surface area, despite the length of the strip.

This type of storage can be used along a lane or in an independent parking lot. It is recommended for larger car parks.

❖ Finial storage

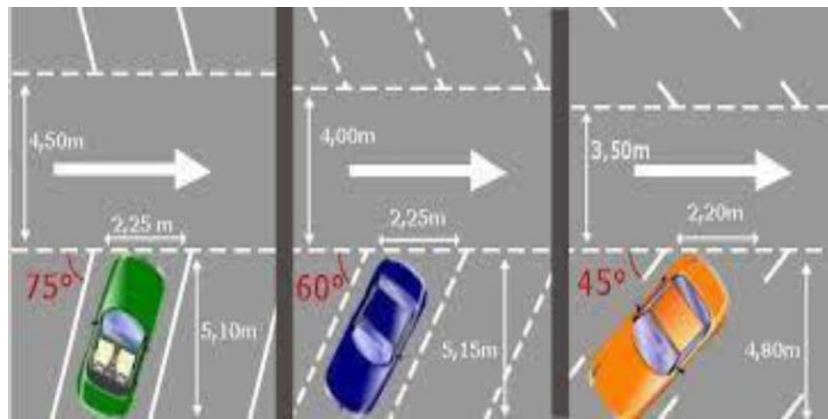


Figure 1.7 : Finial storage

This type of storage unit is designed with different angles of inclination (Figure 1.7):

- either 60°
- or 45°
- or 30°.

Approx. 27 cars per 100 m

This type of storage facilitates rapid maneuvering and minimizes the time spent obstructing traffic. It is recommended for car parks with a high volume of traffic and short-term parking.

The disadvantage is that it is less economical in terms of surface area, without allowing a large number of cars to be parked.

- **Dimensions of a disabled car park**

An extra width of 0.50m is required.

Width: 3.70m

I.7 SIDEWALK

I.7.1 INTRODUCTION

Sidewalks and pedestrian walkways play a specific role in the road system, channeling pedestrian traffic and making it independent of vehicle traffic and parking. While sidewalks complement roadways and provide safety for pedestrians, footpaths are strictly reserved for human use.

However, certain vehicles may be admitted on an exceptional basis (delivery or removal trucks, emergency vehicles).

I.7.2 SIDEWALK WIDTH

The standards require that the minimum width of the sidewalk be determined by the fact that a pedestrian and a pram can pass each other without hindrance. This results in the following dimensions for the sidewalk of a tertiary roadway:

- 1.50 m when the sidewalk has no obstacles.
- 2.00 m when the sidewalk has public lighting columns.
- Sidewalk widths can be increased by 5 m to 9 m by planting one or more rows of trees.

Sidewalks have a transverse slope of between 1% and 3% to direct runoff water towards the gutter at the edge of the roadway. Runoff is collected in grates or gullies.

I.7.3 PEDESTRIAN WALKWAY:

Pedestrian walkways are road elements reserved for pedestrians, permanently or temporary separated from road traffic. They are created in residential or urbanized areas with a strong commercial presence. Their width is determined by taking into account the ease with which pedestrian flows can cross. They are of the order of :

- 2 to 2.50 m to accommodate signage, street furniture and planting.
- 3.50 to 4.00 m if vehicular traffic is permitted on an exceptional basis.

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Run-off water is conveyed by a longitudinal and transverse slope, and collected in grids at low points (Figure 1.8).

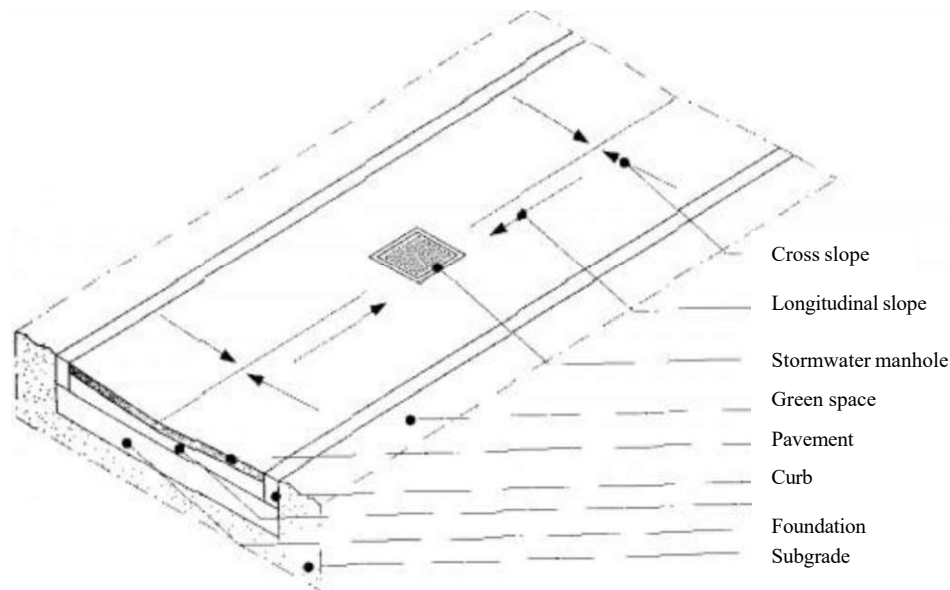


Figure 1.8: Pedestrian walkway

As with roadways, sidewalks and pedestrian walkways are made up of several layers:

- A sub-base of natural or treated gravel, 15 to 30 cm thick, depending on the quality of the subsoil;
- A levelling layer of crushed materials 5 to 10 cm thick;
- A surface dressing layer.
- The last two layers can be combined into a single layer. A combination of several materials may be considered:
 - Black products such as hot mix or cold mix;
 - White, concrete-based products, such as cast-in-situ concrete paving, with or without surface treatment;
 - Paving stones on a sand bed and a levelling layer, in various shapes (square, rectangular,);
 - Natural stone in the form of pavers or slabs, in granite, porphyry, basalt or sandstone;

I.8 KERBSTONES

The physical separation between the roadway and the sidewalk is materialized by curbstones, which constitute an obstacle to the invasion of the sidewalk by vehicles during parking maneuvers. The height of the curbstone depends on its location.

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In front of a garage 7cm. On the bridge 18 to 20 cm. In a tertiary roadway, this height is set at 14 cm.

1.8.1 DIFFERENT TYPES OF CURBSTONE:

A curbstone is a vertical or inclined element bordering pedestrian or vehicular traffic areas, which can form part of a stormwater drainage system.

Curbstones are suitable for all types of structures: road or freeway shoulders, parking curbs, driveways, sports fields or urban roadways, and the contours of directional islands.

There are three types of curbstone:

- concrete curbstone
- stone curbstone
- reconstituted stone curbstone

They are generally divided into three types:

- curbstones (high)
- crossable curbstones
- inclined or rounded curbstones

A. Non-crossable curbstones (high)

T-type curbstones are specifically designed for urban roadways. T1 and T2 curbstones are the most frequently used, but T3 and even higher T4 curbstones are also available. (Figure 1.9)

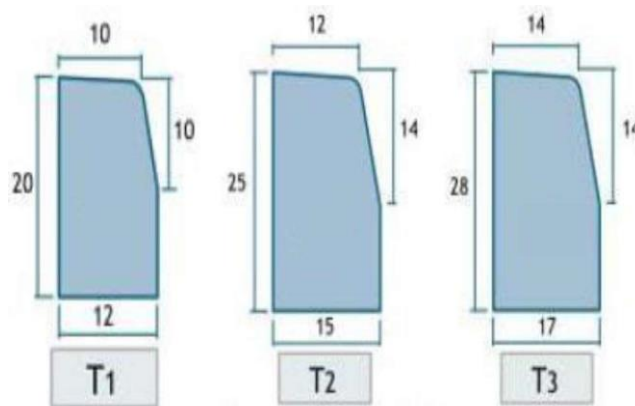


Figure 1.9 : curbstones (high), non-crossable

B. Crossable curbstones

Type A1 and A2 curbstones are crossing curbstones. (Figure 1.10)

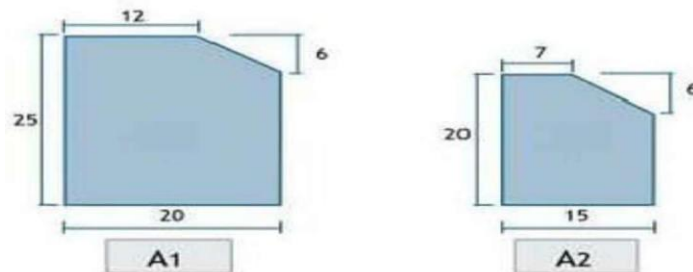


Figure 1.10 : crossable curbstones

CS1 - CS2 - CS3 and CS4 are single-slope curbstones designed for use with either type A or type T curbstones. CS1 and CS2 are the most frequently used curbstones. (Figure 1.11)

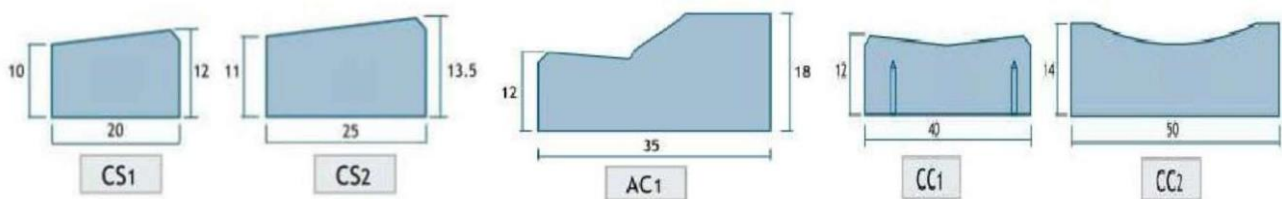
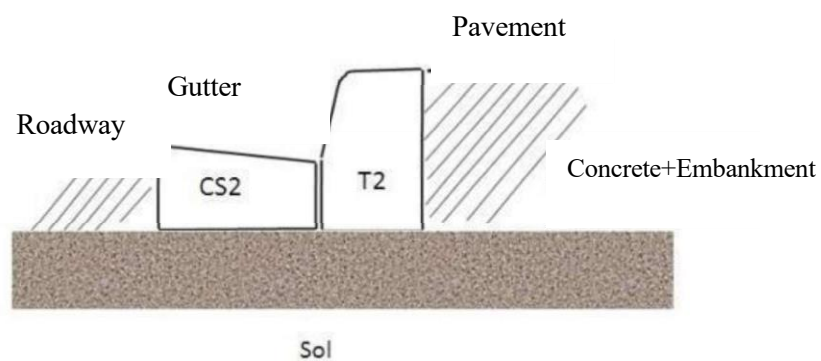


Figure 1.11: Gutter curbstones

Curbstones and gutters must be laid on a fresh concrete bed.



I.9 INSERTION OF THE DISABLED

The insertion of disabled people is governed by specific regulations. They take into account the size of the locality where the improvements are to be made. Disabled people have different

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handicaps. A distinction must therefore be made between wheelchair users, people with reduced mobility and the visually impaired or blind (Figure 1.12).

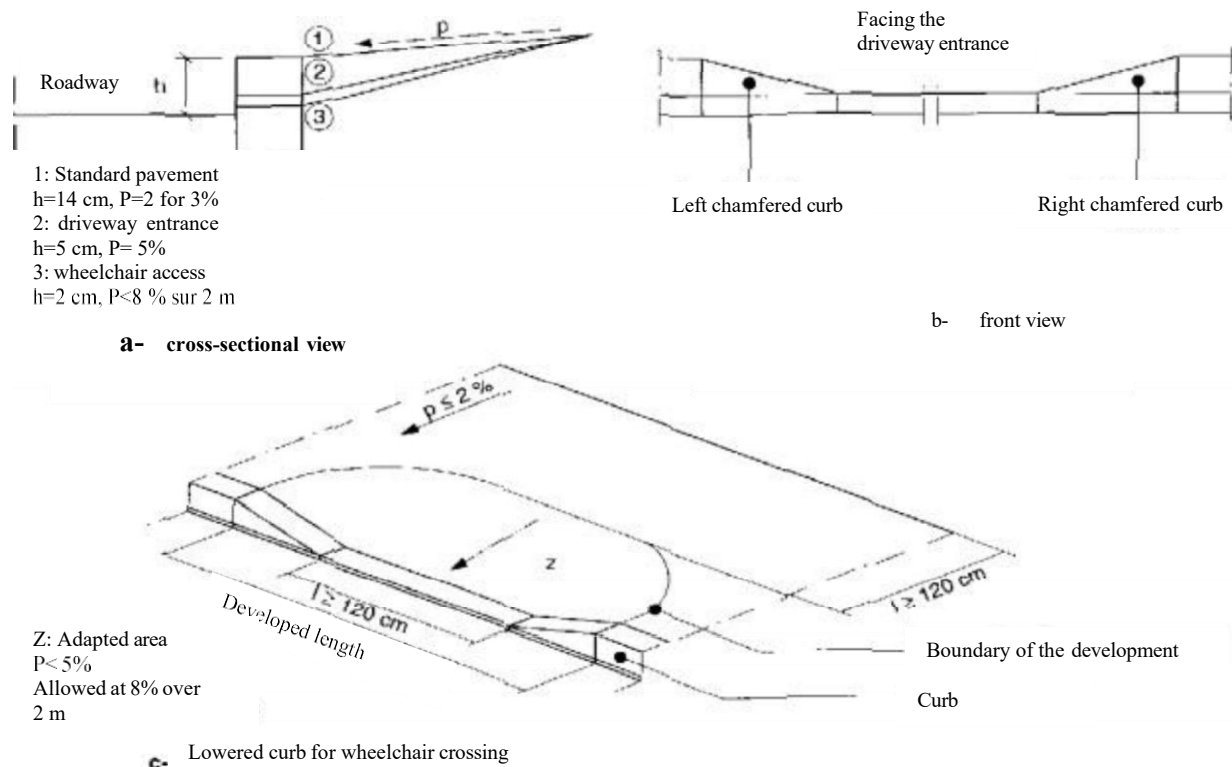


Figure 1.12: Adaptations for disabled people

I. 10 ROUTES RESERVED FOR EMERGENCY VEHICLES

The purpose of these routes is to enable emergency services to intervene in the immediate vicinity of buildings and reach all premises, either directly or via a safe route (balconies, terraces). They can be laid parallel or perpendicular to the facade.

Routes reserved for emergency vehicles are subdivided into two sections: vehicle routes and ladder routes.

A. Machine tracks

They are reserved for access. According to regulations concerning residential buildings, they have the following characteristics (Figure 1.13):

- Minimum tread of 3.00 m;
- Minimum inside radius of curvature R equal to 11.00 m; an extra width $S=15/R$ is less than 50.00 m;
- Clearance height of porches greater than or equal to 3.50 m, allowing the passage of

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equipment with a height of 3.30 m, plus a safety margin of 0.20 m;

- Maximum gradient of 15% ;
- Roadway structure designed to withstand a load-bearing capacity of 130 KN distributed load.

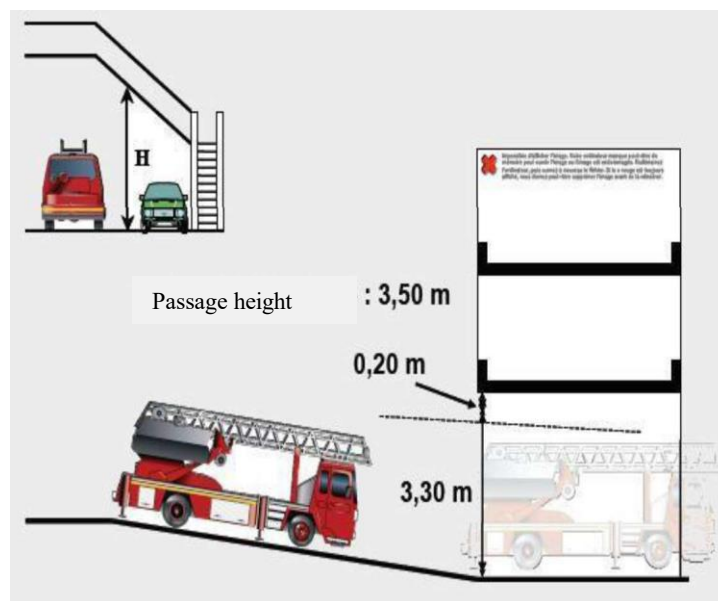
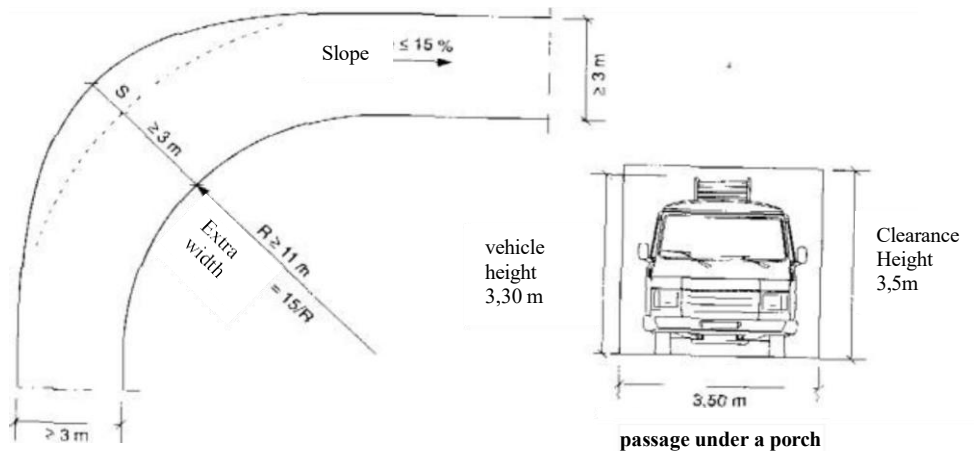


Figure 1.13: machine tracks

B. Ladder tracks

Fire-fighting vehicles equipped with ladders can use them. They have the following characteristics (Figure 1.14):

- In areas of use, the clear width is increased to 4.00 m over a minimum length of 10.00m;
- The maximum gradient is 10%;
- The pavement structure must have a punching resistance greater than 100 KN over a 20

CHAPTER I : Roadworks

cm diameter surface.

This type of road, designed for normal traffic conditions, is constructed using standard techniques: asphalt, concrete or paving.

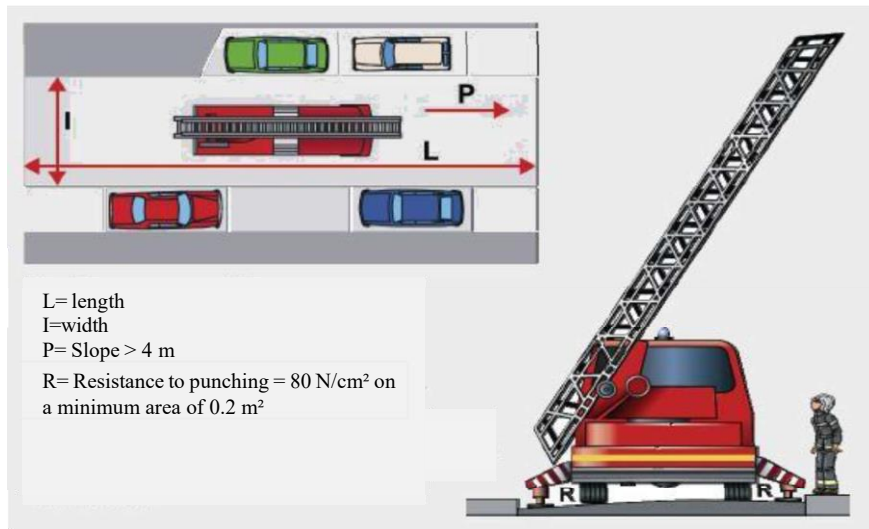


Figure 1.14: Ladder track

CHAPTER II

SEWERAGE

CHAPTER II :SEWERAGE

II.1 Definition of the Sewerage System

As a general rule, wherever people live, and especially in built-up areas, water of all kinds must not be allowed to run off naturally. It must be guided and channelled towards natural or artificial outfalls, and in some cases purified and treated before being finally discharged.

II.1.1 Overview of sewerage principles

The purpose of sewerage is to collect all polluted water, i.e.:

- domestic wastewater from sanitary appliances
- industrial wastewater
- meteoric water

It should be underlined that certain types of wastewater, particularly industrial wastewater, require special treatment in wastewater treatment plants before they are finally discharged into the environment.

II.1.2 Residual water

There are 4 categories:

- household water
- run-off water
- black water
- industrial residual water

II.2 PRINCIPLES OF SEWERAGE SYSTEMS

Sewerage systems are generally of the gravity type, with effluent flowing by gravity. Pipes are designed to operate in free-flow mode, and not to be subjected to pressurized circulation.

The network layout is designed to allow effluent to flow and be discharged as quickly as possible, without causing nuisance to the surrounding area (unpleasant odors, overflow, etc.).

It takes several parameters into account

- The location of the area concerned, whether urban, suburban or rural;
- The distribution and purpose of the buildings to be served;
- Road layout;
- The topography of the land to determine the slope of the pipes;

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- The elevation of the point of discharge into the public network or the natural environment;
- Possible extension of the network;
- Protection of the surrounding environment, e.g. water catchment areas;
- Presence or absence of a water table;
- Overall project economics (investment and maintenance costs);
- Coordination with other existing or planned networks;
- Conditions of construction under public or private property;
- positioning of access points for future maintenance.

II.2.1 The basic principles

Networks are designed according to three basic principles, depending on whether wastewater and rainwater are collected in a combined (Figure 2.1) or separate system (Figure 2.2).

A. **Combined system:** all wastewater and stormwater is evacuated via a single network, i.e. a single pipe designed accordingly.

✓ **Advantages :**

- economical (lower cost)
- easy to connect and install.

✓ **Disadvantages :**

- relative pollution of the receiving environment
- disruption to treatment plant operation



Figure 2.1: Combined system

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B. separative system :

This consists of two separate pipes, one for rainwater and the other for wastewater.

✓ Advantages :

- the treatment plant is simply sized (low)
- efficient operation of the treatment plant.

✓ Disadvantages :

- implementation of separative system (high cost)
- connection problems
- Pollution from early rainfall persists in the receiving environment.



Figure 2.2: Separative system

C. pseudo-separated system:

Depending on the residential area, this network is made up partly of a combined system and partly of a separate system.

Meteoric water is divided into two parts:

- One part comes solely from road surfaces, and is discharged directly into the environment.
- The other comes from roofs, courtyards and gardens, which discharge into the network

using the same connections as for wastewater.

✓ Advantages and disadvantages:

This system is comparable to the separate sewer system, but without connection problems, on the other hand, it does disrupt the operation of the wastewater treatment plant.

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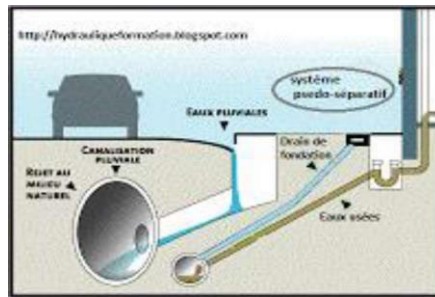


Figure 2.3: pseudo-separated system

II.3 THE GENERAL ARRANGEMENTS

To the extent possible, networks are adapted to the topography of the ground. Depending on the configuration of the catchment area, different schemes can be adopted, avoiding excessive depths.

- On common ground, the principle adopted is that of a branched network. The main collector, which can be visited, receives the secondary collectors to which the antennas are connected.
- On almost horizontal ground, the antennas are connected to central points, which are in turn connected to a visitable general collector.
- On gently sloping ground, antennae are taken up by secondary collectors which join the general collector obliquely downstream.
- On uneven ground, several secondary pipes collect the antennas at different levels (stepped zones) before being connected to the general collector.

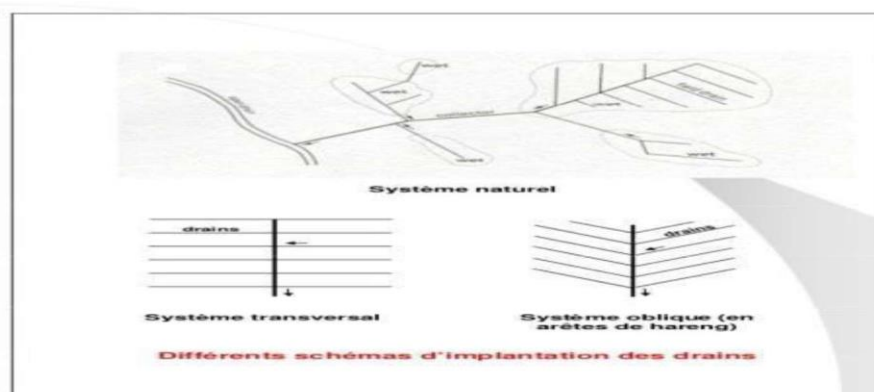


Figure 2.4: general arrangements

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A. The pressurized network

Designed to evacuate domestic wastewater from residential or commercial buildings, excluding rainwater.

It consists of a receiving tank equipped with a pumping station generating sufficient pressure to transport the loaded water in a single pressurized pipe to a discharge point.

The network comprises a manhole equipped with a grid to retain large elements, a set of pumps, isolation valves, a backflow prevention device and a malfunction alarm system.

Pipe diameters are calculated to achieve a minimum flow velocity of 0.7 to 1 m/s.

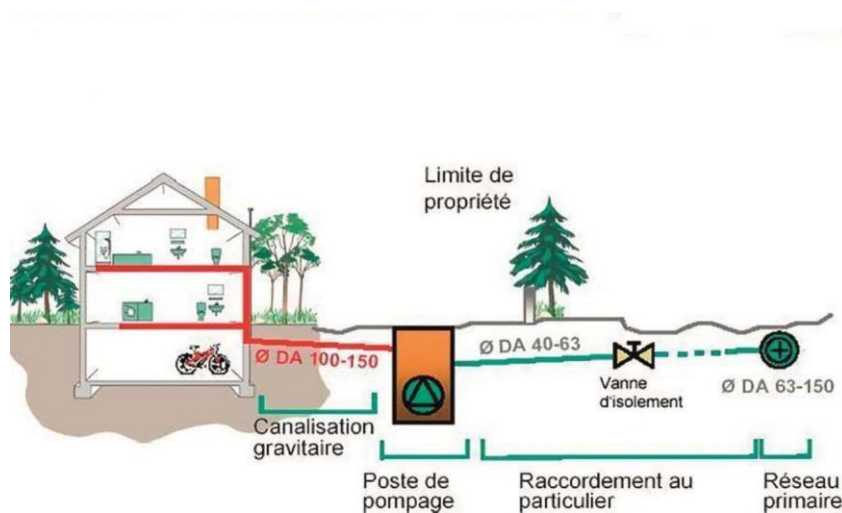


Figure 2.5 : The pressurized network

B. The vacuum network

Similar to its predecessor, it carries domestic wastewater, excluding rainwater.

It comprises the following components

- A vacuum station comprising a storage tank, which may or may not be kept under vacuum depending on the ejection mode, a lifting unit (if required) and a control device to prevent the system from becoming clogged;

- Collection manholes equipped with an interface valve to allow effluent to pass through; The network operates as follows: wastewater flows by gravity to the collection manhole.

When a certain level is reached, a valve opens, connecting the manhole to the vacuum network.

The pressure differential between the atmosphere and the collector draws the wastewater into the latter. The system is completed by non-return valves and an alarm system in the event of any malfunction.

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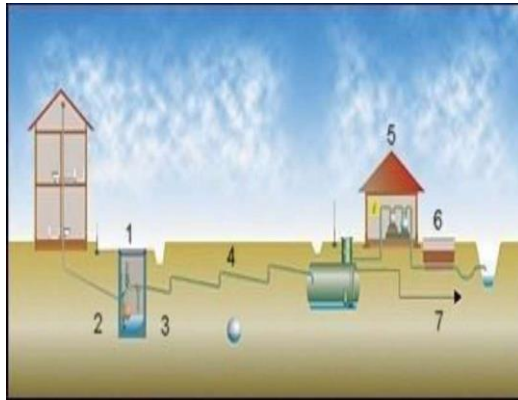


Figure 2.6: The vacuum network

II.4 QUANTITY AND QUALITY OF WATER TO BE DISCHARGED

Water quantities depend essentially on the type of land use, the density and purpose of buildings, any extensions and the quality of the external environment.

Depending on the nature of the catchment area, the quantity and nature of the effluent collected will differ: urban centers, residential areas, rural areas, industrial estates, shopping centers, etc.

For this reason, we distinguish between meteoric or rainwater, runoff (rainwater, washing water, etc.), domestic wastewater, non-domestic and industrial wastewater, and parasitic water.

- Rainwater: roof water and surface runoff.
- Run-off water: this is rainwater and road-washing water.
- Domestic wastewater: toilet water, household water and black water.
- Non-domestic wastewater: water from cooling systems, industrial water, water polluted by hydrocarbons, water discharged by schools, hospitals and laboratories.
- Parasitic water: This includes tank overflow, spring water, drainage water and clandestine discharges.

II.5 Meteoric or rainwater - Runoff water

II.5.1 Meteoric or rainwater

• Rain is an essentially random and discontinuous phenomenon that varies in time and space. It is characterized by several parameters:

- Its duration t ;

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- The total height of precipitation expressed in mm ;
- The average intensity i_m over the duration of the rainfall, corresponding to the ratio of height (h) to duration (t) measured in mm/min or mm/h ;

- The average or maximum intensity for a given period of time;

The return period T, the average time between two events of equal or greater value for a predetermined parameter: ten-year rainfall, for example.

During precipitation, water follows a number of different paths. Depending on the topography of the ground and the nature of the soil, it first infiltrates. When the soil is saturated, and depending on the intensity of the rain, the water runs off it to low points where it accumulates.

Finally, some water evaporates under the action of heat or wind, returning to the gaseous state (figure 2.7).

II.5.2 Runoff water

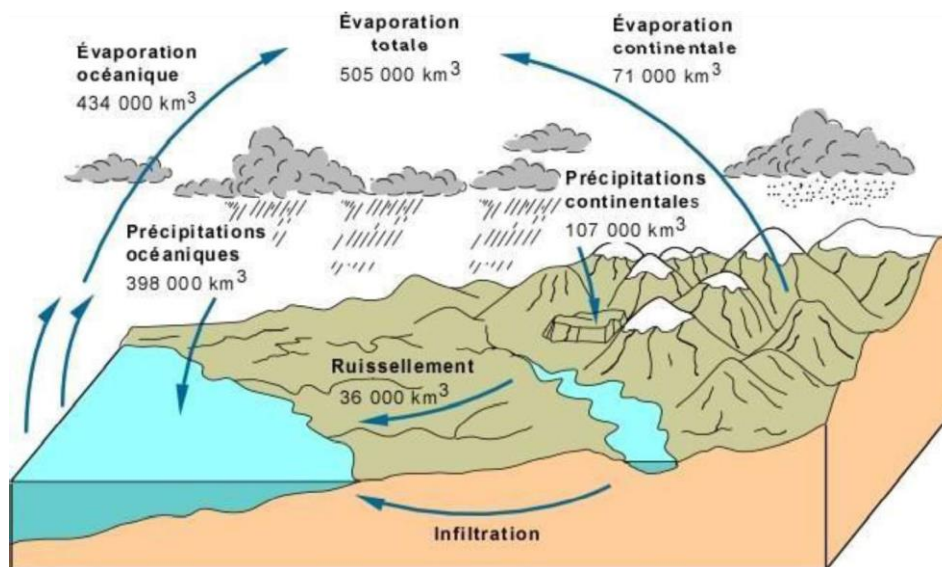


Figure 2.7: This simple diagram shows the water balance on the earth's surface.

Runoff includes the part of rainwater that runs off the ground, to which is added, especially in urban and suburban areas, the water used to wash roads.

- The sewerage system must enable all this water to be collected at low points, and prevent it from forming stagnant zones.

Two parameters are decisive in calculating the peak flow of stormwater:

- The intensity of the event, which is not constant throughout its duration; low at the start, intensity increases during the downpour, then decreases towards the end.

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- The duration of the journey varies according to the distance between the point of inflow and the outlet. Water flows along the lines of greatest slope; the time of concentration is defined as the sum of two factors: the downstream travel time and the upstream time, i.e. :

$$T_c = t_{av} + t_{am} \quad (2.1)$$

Determining flow rates: two of the methods used to determine flow rates are particularly popular.

They are quite similar to each other.

II.5.3 Characteristics of Watersheds

A watershed can be characterized by

- its area,
- its shape,
- its average slope,
- its runoff coefficient

a) Shape:

The shape of a watershed can be characterized by the elongation factor M calculated by the

following formulation: $M = L/A^{0,3}$ (2.2)

Where: L : longest hydraulic path (hm),

A : watershed area (ha).

b) Slope:

The average slope of each watershed is estimated by the following expression:

$$i_{moy} = (\sum L_j / \sum (L_j / i_j^{0,5}))^2 \quad (2.3)$$

Where : L_j : length of segment j belonging to the longest hydraulic path,

i_j : slope of segment j.

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c) Runoff Coefficient:

To characterize the runoff capacity of a watershed, an index very often used in surface hydrology is the runoff coefficient (Cr):

$$Cr = \text{height of runoff water (mm)} / \text{height of precipitation (mm)}$$

This coefficient is strongly influenced by soil cover and slope of the terrain considered. The following two tables present different "ranges" of runoff coefficients depending on the nature of the surface and land use type.

land cover	Runoff Coefficient
- Commercial	$0,70 < C < 0,95$ $0,30 < C < 0,50$ $0,50 < C < 0,75$ $0,25 < C < 0,40$ $0,50 < C < 0,80$ à 0,90 $0,10 < C < 0,25$ $0,05 < C < 0,15$ à 0,20 $0,10 < C < 0,13$ $0,03 < C < 0,07$ à 0,10
- Résidentiel	
Development	
Collective	
Dispersed housing	
- industrial	
- Parks and public gardens	
- Vacant lots	
- agricultural lands	
Drained	
Undrained	
Surface type	
- Paving, Paved roads, Concrete tracks	$0,70 < C < 0,95$
- Roofs and terraces	$0,75 < C < 0,95$
- Impermeable surfaces with vegetation	
Slope < 2 %	$0,13 < C < 0,18$
Slope = 2 à 7 %	$0,18 < C < 0,22$ à 0,25
Slope > 7 %	$0,25 < C < 0,35$
- Permeable surfaces with vegetation	
Slope < 2 %	$0,05 < C < 0,10$
Slope = 2 à 7 %	$0,10 < C < 0,15$
Slope > 7 %	$0,15 < C < 0,20$

Estimation of Flows Before and After Development. The formulas used to determine these flows are presented below.

1. Rational Method:

This method allows estimating the 10-year peak flow (Q(10)):

$$Q_{10} \text{ (l/s)} = 0,167 * C * I * A^{0,95} \quad (2.4)$$

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Where:

- Q_{10} : 10-year peak flow (l/s),
- C: runoff coefficient,
- A : total watershed area (ha),
- I : rainfall intensity over the concentration time t_c (mm/h).

a) Rainfall Intensity:

Rainfall intensity is obtained from Montana's equation:

$$I_{(t,F)} = a (F) t_c^{-b(F)} \quad (2.6)$$

Where:

- $I_{(t,F)}$: maximum rainfall intensity of duration t (minutes), with exceedance frequency F(mm/mn).
- a and b are Montana's coefficients.

b) Concentration Time t_c :

The concentration time t_c (in minutes) is the time taken by the most distant raindrop from the outlet to reach it.

It can be calculated by dividing the length of the longest drain by the flow velocity:

$$t_c = L / (60 * V) \quad (2.7)$$

Where :

- t_c : concentration time (mn),
- L : length of the longest hydraulic path (m),
- V : average flow velocity (m/s).

Flow velocities are given in « Recommendations for Road Sanitation (SETRA, 1982) ».

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Table 2.1:Flow Velocity Values (SETRA, 1982)

Slope of the catchment area %	Flow velocity in m/s		
	Pasture (Upper part of the watershed)	Woodland (Upper part of the watershed)	Poorly defined natural catchment
0 à 3	0,45	0,30	0,30
4 à 7	0,90	0,60	0,90
8 à 11	1,30	0,90	1,50
12 à 15	1,30	1,05	2,40

To obtain the total flow time in the watershed, the longitudinal profile of the watershed is divided into segments of homogeneous slope. The total flow time is obtained by summing the flow times of each segment

2. Caquot Method Surface Method):

This method is the most frequently used to calculate the maximum flows of an urban watershed. It is described in the 1977 Technical Instruction (IT 77). It establishes the peak flow (Q) of exceedance frequency (F) (or return period T, with $(T = 1/F)$):

$$Q(F)\{m^3/s\} = k \cdot i^\alpha \cdot C^\beta \cdot A^\gamma \cdot m \quad (2.8)$$

Where:

- Q(F) : peak flow with return frequency F(m³/s),
- i : average slope of the considered surface (en m/m),
- C : : imperviousness coefficient (impervious surface / total watershed area)
- A : watershed area (ha),
- m : shape correction coefficient,
- K, α, β, γ: constants defined in the model, functions of the two coefficients a(F), b(F) from Montana. These parameters depend on the region considered and the return period T of the rainfall.

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A. Validity Limits of the Method:

- Watershed area A less than 200 ha,
- Watershed slope i between 0.2% and 5%,
- Imperviousness coefficient greater than 0.2.

B. Equivalent Parameters for a Group of Watersheds

The surface formula derived from the Caquot model can only approximate reality if the watersheds have homogeneous physical characteristics. Therefore, it requires the use of equivalence formulas for the parameters (A, C, I, and E) of the group. These formulas, which differ depending on whether the watersheds making up the group are arranged in parallel or in series, are given below:

Table 2.2: Equivalent Parameters for a Group of Watersheds

	A_{eq}	C_{eq}	I_{eq}	E_{eq}
Watersheds in series	$\sum A_i$	$\frac{\sum C_i \cdot A_i}{\sum A_i}$	$\left[\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{I_i}}} \right]^2$	$\sum L_i / \sqrt{\sum A_i}$
Watersheds in parallel	$\sum A_i$	$\frac{\sum C_i \cdot A_i}{\sum A_i}$	$\frac{\sum Q_p \cdot I_i}{\sum Q_p}$	$L(Q_{i_{max}}) / \sqrt{\sum A_i}$

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II.5.4 Domestic sewage

Domestic wastewater is a polluted effluent that includes household water (from cooking, washing, laundry, etc.) and black water from WCs. It contains mineral and organic matter in two forms:

- Suspended solids (SS), which can be volatile, settleable or non-settleable; they are one of the parameters of the degree of pollution;

- Dissolved matter.

Domestic wastewater is characterized by several parameters:

- Biochemical oxygen demand (BOD), the quantity of oxygen consumed by the chemical oxidation and degradation of organic matter.

- Chemical Oxygen Demand (COD), the amount of oxygen required to degrade organic matter.

- Oxidizable matter (OM), determined by the weight average of BOD5 and COD measured after a two-hour settling period:

$$OM = (COD + 2 \times BOD5) / 3 \quad (2.13)$$

- Total organic carbon (TOC), measured by combustion of organic matter.

- Organic and oxidized nitrogen content.

- Presence of fats.

- Presence of metals.

- Presence of micro-organisms, bacteria, viruses or parasites.

- The quantity of water to be collected varies according to the urbanization of the area concerned and the number of inhabitants. In principle, it is closely related to water consumption.

- Daily consumption is not evenly distributed over the twenty-four hours. The same applies to discharges, which have peak and off-peak periods (particularly at night), expressed as a percentage of average daily flow Q_j .

- The peak flow corresponds to the instantaneous flow used to calculate the pipe diameter; it is given by the following formula:

$$Q_p = C_p \times Q_m \quad (2.14)$$

- where :

- Q_m is the average flow rate expressed in liters per second ($Q_m = Q_j / 86,400$);

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▪ C_p is a peak coefficient that depends on the location of the collector, its cross-section and the size of the city.

II.5.5 Non-domestic and industrial water

The quantity and quality of water to be collected depends essentially on the type of establishment and industry, and the size of the site.

Non-domestic water discharges must be declared to and authorized by the local authority. The degree of noxiousness, the temperature of the effluent and any off-gassing must not present a danger to maintenance personnel or compromise the proper operation of the sewerage system.

Some large facilities have their own effluent treatment units. Generally speaking, however, several solutions are available.

C. Rainwater

Are either discharged with wastewater, in the case of combined sewer systems, or, preferably, collected separately and sent to a settling or pre-treatment basin when it is only slightly polluted, before being discharged into the natural environment.

D. Sewage

Wastewater from sanitary installations is collected in a collector, which may or may not also collect rainwater, depending on whether the system is combined or separate. It is then channeled into the sewerage system.

E. Industrial water

When industrial wastewater contains harmful substances, it must be treated at source before being discharged into the sewerage system.

II.6 PIPE DIMENSIONING

Having defined the sewerage network's layout and its upstream origin and downstream discharge elevations, it is time to calculate the cross-section and gradient of the various sections that make up the network. These are determined based on several parameters:

- ✓ Quantity of effluent to be discharged;
- ✓ The nature of the effluent;
- ✓ The characteristics of the pipe material;
- ✓ The length of the pipe and the various accidents along the way (change of direction, manholes).

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The network is made up of a number of branches of specified length, joining at nodes N1, N2, N3 and so on. As the flow rate is known for each branch, it is possible to determine its cross-section and slope, two closely related factors.

The network is of the gravity type, and is calculated according to the free-flow principle.

The flow rate is given by the equation

$$Q \text{ (m}^3\text{/s)} = S \text{ (m}^2\text{)} \times V \text{ (m/s)} \quad (2.15)$$

Where :

- S is the cross-sectional area of the pipe occupied by the effluent;
- V is the effluent velocity, itself a function of slope and flow coefficient.

II.7 The composition of sewerage networks

Sewerage networks collect water with varying loads and convey it in the best possible conditions. The priority is to ensure the transfer of polluted water to the treatment plant while protecting the natural environment.

To this end, the flow must be as direct as possible, without encountering obstacles that could lead to blockages, or weak points that could be sources of leakage into the surrounding environment or infiltration of parasitic water.

They include structures with very specific functions: pipes and collectors, manholes (both accessible and non-accessible) and ancillary structures.

II.7.1 Collectors and pipes

Collectors are considered to be free-flowing aqueducts with watertight joints. Their dimensions decrease from downstream to upstream. A sewerage network comprises the following elements: main sewers, secondary sewers and connections.

❖ Main collectors

These are either circular-section pipes with a diameter in excess of 800 mm, or prefabricated or cast-in-place ovoid pipes, with heights ranging from 1.00 to 2.65 m depending on whether or not they are visitable; or visitable cast-in-place concrete structures with a culvert and one or two benches.

- .1. Secondary manifolds** are generally cylindrical, with a diameter of less than 800 mm.
- .2. Connection pipes** are also cylindrical, with a diameter greater than 150 mm.

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Frequently located beneath the roadway, pipes are installed to withstand the overloads they support. Pipes are tested for resistance to crushing, bending, abrasion and corrosion. They are also tested for tightness and porosity.

They are made from the following materials: unreinforced compressed or centrifuged concrete, reinforced centrifuged concrete, stoneware, cast iron, polyvinyl chloride (PVC), glass-fiber-reinforced polyester (GRP).

Each of these materials has its own specific characteristics, and complies with very precise manufacturing standards and certifications.

II.7.2 Manholes

Manholes have a variety of functions, depending on their position within the sewerage system. Placed at particular points and depending on their size, they enable access to the network, maintenance, connection of sewer connections, water collection, and control of flow and the nature of the effluent.

Manholes are made of cast-in-place or prefabricated concrete, cast iron or synthetic materials (PVC, polyethylene). Walls must be watertight, and their thickness must be able to withstand mechanical stresses, both internal (temporary pressure) and external (backfill, surface loads).

Made of precast concrete, square or circular in cross-section, manholes comprise the following elements:

- A base consisting of an invert with or without a cunette;
- One or more straight elements;
- A sealing device.
- Sealing is ensured by the interlocking of the elements, supplemented by a flexible rubber or plastic gasket compatible with the nature of the effluent.
- The shut-off device consists of a frame housing a concrete, cast-iron or steel closing plug, or a cast-iron grate.

This assembly is classified as either heavy-duty or light-duty, depending on the location of the manhole and the load applied to it: under pavements, sidewalks or green spaces.

❖ Access chimneys

Manholes are designed to provide access to the sewerage system for inspection and cleaning purposes, whether or not the sewers can be visited.

In the former case, they are installed at regular intervals to facilitate maintenance.

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In the latter case, access must be provided at the head of the collectors, at the junction of two or more collectors, at each change of direction or slope and at regular intervals, with straight alignment between two successive manholes.

The distance between two manholes must not exceed 40 to 50 m for non-accessible collectors and 100 m for others.

Square in cross-section, they have the following dimensions: 0.80 m x 0.80 m or 1.00 m x 1.00 m; circular in cross-section, they have a diameter of 0.80 m or 1.00 m. Made of cast-in-place or precast concrete, they comprise the following elements (see figure):

- A bottom made up of an invert with a cunette ;
- A vertical chimney made up of several straight elements fitted with rungs if the depth exceeds 1.50 m;
- A reducing head to reduce the cross-section of the chimney to that of the free passage;
- An upper element supporting the closing buffer frame.

This assembly is classified as either heavy-duty or light-duty, depending on the location of the manhole and the load applied to it: under pavements, sidewalks or green spaces.

❖ Sewer connections

Each building and structure is connected to the main sewer by means of a connection, enabling the various effluents to be discharged into the sewer. Depending on the type of network to which buildings are to be connected, connections are either single (combined sewer system) or double (separate sewer system). They must take several parameters into account:

- Flow rate and quantity of water discharged;
- The type of collector and its depth;
- The outlet level of the private network;
- The possible presence of pipes or electrical cables;
- The possibility of serving two neighboring buildings or groups of buildings.

Connections are made up of three distinct elements: a facade manhole; a connecting pipe; and a connection to the main sewer.

❖ Stormwater and runoff collection facilities

These collection structures are designed to collect or channel rainwater and runoff or wash water from paved surfaces. They include manholes at the foot of the chute; grating manholes; avaloirs; floor drains; gutters and ditches.

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❖ Manholes at the foot of the chute

Footfall manholes are small structures (300 or 400 mm square cross-section) used to connect a vertical drop to a low-gradient pipe.

✓ Grated manholes

Grated manholes are one-off structures whose cover is made up of a grating for water collection. The grating is made of cast iron, steel or PVC, depending on the area in which it is located. They must withstand the loads they carry.

✓ Gullies or manholes

Gullies are elements placed along curbstones to collect surface water. They are generally located at the lowest point of the road. However, when the roadway has a steep longitudinal slope, the gullies are placed on the water line with a slight offset to ensure better collection of run-off water.

✓ Floor traps

Floor traps are elements that collect runoff water on small surfaces with slopes designed to collect the water at low points. They come in two forms.

- The bell-type floor trap consists of a concrete manhole on which is fixed a frame that accommodates a cast-iron bell-type grate. Its purpose is to ensure water drainage and prevent odors from rising.

- Basket floor traps feature a grate, a removable basket to stop waste and a partition to prevent odors from rising.

Regular maintenance is essential to ensure that they fulfil their role to the full.

✓ Gutters

Gutters are linear structures that collect runoff water over a certain length, determined by their positioning. They come in two forms: open and closed gutters.

CHAPTER III

MISCELLANEOUS

NETWORKS

CHAPTER III : MISCELLANEOUS NETWORKS

Miscellaneous networks form an essential part of the adaptation of spaces, whether urban or rural, and whatever their destination.

III.1. Drinking water supply networks (AEP)

III. 1.1 Drinking water supply

Water is essential to everyday life, not only in the domestic sphere, but also in industry and agriculture.

Water distribution is the responsibility of local authorities (communes, groups of communes,). When they have the appropriate departments, they take charge of distribution themselves. They may also entrust it to a para-public or private company. Distributed under pressure in networks sized according to needs, or obtained by pumping into the water table to serve isolated housing or agricultural requirements, it is used in all fields of activity.

III.1.2 Water requirements

The aim of the water supply system is to meet the needs of the various uses: domestic, tertiary, industrial, watering of plantations, washing and cleaning of public spaces, fire-fighting. These needs are quantified in order to define the characteristics of the distribution network in the adaptation zone. Assessing these needs is a relatively delicate task, since it depends on: the purpose of the buildings (residential, tertiary, industrial), the location (urban or rural), the size of the area to be served, the importance of public spaces and the possibility of a future extension. Two factors influence average consumption:

- Time of year: monthly consumption is weighted by a correction coefficient equal to 0.5 in winter and 1.5 in summer;

- The time of day: the flow rate changes in a proportion of 1 to 7 between off-peak and peak hours.

A common formula for calculating flow rate is as follows:

$$Q = 4 \times C \times N \times 1/86\ 400$$

C: Daily per capita consumption (Litre/second)

N : Number of inhabitants

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III.1.3 The distribution network

Connected to the general network via a valve. It is an assembly of several pipes in series or in parallel, accompanied by a set of accessories (fire hydrant valves), designed to perform very specific functions.

III.2 THE DIFFERENT TYPES OF NETWORK: THERE ARE TWO TYPES OF NETWORK

III.2.1 branching network:

This is the oldest system, with water flowing in the same direction, i.e. no back-feeding of pipes. It is an economical system, but it has a major drawback in terms of safety and flexibility when a stoppage occurs at a point; it forces us to isolate all or part of a network located downstream; it has the advantage of being easy to build and calculate.

III.2.2 mesh network:

The advantage of this system is that it considerably simplifies operation, since power cuts can be made by isolating a single mesh, while the rest is always supplied. At peak times, point overloads are absorbed by the multiple supply possibilities.

- ✓ **Advantage:** guaranteed safety in the event of failure.
- ✓ **Disadvantage:** costly and complex to calculate

The distribution network is made up of pipes, connection fittings and various components such as shut-off valves, hydrants, hydrants for watering or washing, fire hydrants, meters, backflow preventers and so on.

All components must be sufficiently resistant to prevent damage from overpressure and water hammer caused by valves opening or closing unexpectedly.

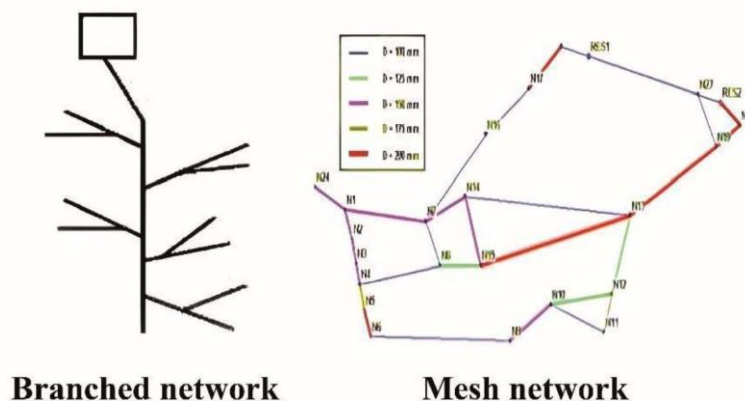


Figure 3.1: The different types of network

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III.2.3 Calculation of a Looped Network Using the Hardy-Cross Method

The calculation of a looped network is performed using the Hardy-Cross method, which is based on successive approximations and relies on two fundamental laws: the loop law and the node law.

- **Node Law**

For each node, the sum of inflows equals the sum of outflows.

- **Loop Law or Conservation of Head**

Along a closed and oriented path, the algebraic sum of head losses is zero (Figure 3.2). For each loop, an arbitrary distribution of flows and a flow direction are assumed, while respecting the node law.

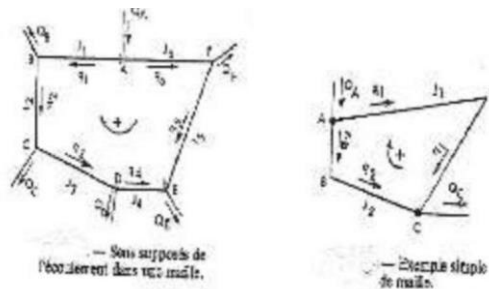


Figure 3.2; Principe of the Hardy-Cross Method

Problem formulation:

The problem reduces to solving the following system of equations:

- For each node:

$$Q_{\text{exiting}} = Q_{\text{entering}} = 0 \dots (3.1)$$

- Along a closed and oriented contour:

$$\sum \Delta H_{t,i} = 0 \dots (3.2)$$

where ΔH_t is the total head loss along pipe segment i (in meters).

Flow distribution and head loss relation

Consider any loop in a network composed of ppp pipe segments. For each segment in the loop, initial

CHAPTER III : MISCELLANEOUS NETWORKS

flow rates Q_1, Q_2, \dots, Q_n are assigned so as to satisfy the flow balance principle. Let ΔH_t be the total head loss in any segment of the loop. It is related to the flow Q by the formula:

$$\Delta H_t = r \sum_i Q^2 \dots (3.3)$$

where r is the pipe resistance coefficient.

The principle of head loss balance is expressed as:

$$\sum \Delta H_t = \sum r Q^2 = 0 \dots (3.4)$$

The symbol \sum denotes the algebraic sum of all head losses in a loop formed by segments each carrying flow Q_i .

Flow correction

The assumed flow Q' differs from the actual equilibrium flow Q by a correction Δq , which must be applied to the arbitrary flow Q' to satisfy the head loss balance principle:

$$Q = Q' + \Delta q \dots (3.5)$$

where Δq is expressed algebraically.

Applying equation (4) gives:

$$\sum \Delta H_t = \sum r Q^2 = \sum (Q' + \Delta q)^2 = 0 \dots (3.6)$$

Since Δq is assumed small compared to Q' , terms involving Δq and higher orders can be neglected in the expansion of (6), yielding:

$$\Delta q = -\frac{\sum \Delta H}{2 \sum \frac{\Delta H}{Q}} \dots (3.7)$$

The correction Δq thus calculated is algebraically added to each initially chosen flow Q' to obtain a better flow distribution in the considered loop:

$$Q' = Q_i + \Delta q \dots (3.8)$$

Iterative procedure and convergence

- For pipe segments belonging to two loops, a double correction is applied.
- The procedure is repeated for iteration $n+1$ with the new flows Q' .
- The iteration stops when the correction satisfies the convergence criterion:

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$$\Delta q < 10^{-1} \text{ à } 10^{-3} \text{ L/s}$$

III.3 THE MATERIALS USED

Whether for pipes or equipment (valves, gates, meters, ...), materials are adapted to the objectives to be achieved: mechanical resistance, shock resistance, water flow resistance, corrosion resistance, etc.

For water intended for human consumption, the materials used in pipes, fittings, tanks and accessories must meet special specifications.

III.3.1 Pipes

Pipes are made from the following materials: reinforced concrete, cast iron, galvanized steel, PVC, polyethylene. The use of asbestos cement is prohibited, as are all products containing asbestos.

III.3.2 Equipment

They are essentially made of materials offering good resistance to wear and friction. Large-diameter fittings have cast-iron bodies; others are made of bronze, brass or synthetic resin.

III.3.3 Individual connections

These are the pipes and structures located between the public network and the point where water is delivered to the customer, whether private, industrial or other. They are always laid perpendicular to the main pipeline (figure 3.3).

Water connections comprise the following components:

- A water intake on the public network pipe;

Pipes of appropriate diameter;

- A quarter-turn shut-off valve controlled by a key, located under the public domain to isolate the connection;

- A shut-off device immediately before the meter;

- A metering device located either in a manhole at the property line, or in the building;

- A device to protect the public network against the risk of backflow from the private network, located after the meter.

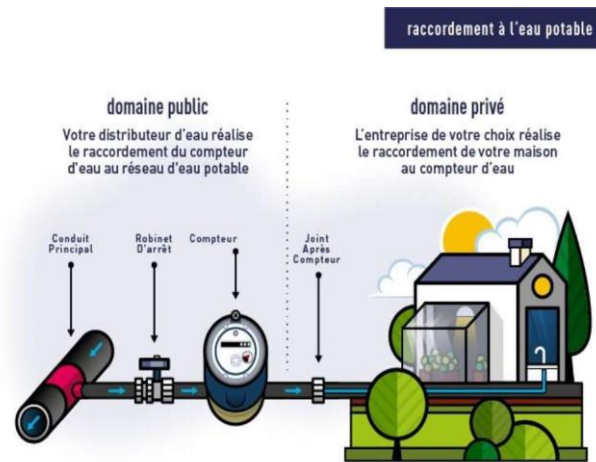


Figure 3.3: Individual connections

III.4 FIRE DEPARTMENT AND RESERVES

Fire-fighting equipment is subject to strict regulations. The aim is to optimize the reliability of fire-fighting equipment in all circumstances, for rapid use by the emergency services. The connection is made to a pressurized water network, whether public or private.

Fire-fighting can be approached in two ways:

- From inside buildings, using devices installed at the time of their construction and adapted to their design and intended use;
- From the outside, by connecting to judiciously distributed fire hydrants.

As soon as a project for the adaptation of an area or the construction of a building or group of buildings (residential, school, establishment receiving the public, industrial, etc.) has been finalized, the designer contacts the fire and safety services in order to define the means to be implemented in the fire-fighting context and their layout.

III.4.1. The electricity distribution network

electricity distribution is provided by sonelgaz (in Algeria). Particular attention must be paid to electrical installations, given the risks incurred by maintenance personnel and users.

III.4.2 Electricity requirements

These are evaluated according to the purpose of the buildings served: residential, tertiary, commercial, industrial, etc. The study should take into account changes in power demand due either to improved comfort and living conditions, or to the expansion of urbanized areas.

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III.4.3 Distributed current characteristics

These refer to the nominal voltage. In the case of alternating current, there are two voltage ranges.

✓ **Low-voltage current (LV)**

Rated at more than 50 volts, but not more than 1,000 volts.

✓ **High-voltage current**

High-voltage current A (HVA) This has a rated value of over 1,000 volts, without exceeding 50 kilovolts.

High-voltage current B (HVB) Rated at over 50 kilovolts.

Very-high-voltage A (VHV) This reaches much higher values, and is used only for long-distance power transmission lines.

This leads us to adopt the following distribution principle:

- HV lines are reserved for :

- main lines serving built-up areas ;
- secondary lines for branch lines in rural areas;
- direct access to transformer substations to meet a large demand for power from a group of buildings or a specific customer;

- LV lines are reserved for:

- lines serving a neighborhood or residential area;
- subscriber connections.

III.4.4 Distribution networks

These are made up of electrical cables with one or more active conductors. They run from the point of connection to the main network to serve all the branches corresponding to individual or collective connections, each of which is controlled by an isolating device (figure 3.4).

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Distribution networks are built according to four main principles: overhead networks, networks laid in surface troughs, networks passing through structures, and underground networks.



Figure 3.4: distribution networks

III.4.5 Electrical components of distribution networks

These include cables, junction boxes and switching and protection devices.

III.4.5.1 Electrical cables

These comprise one or more active conductors with a copper or aluminum core, surrounded by a synthetic resin insulation and a protective sheath.

They are divided into two main groups:

- Twisted cables: used in the construction of overhead lines whose voltage does not exceed 1 kv.
- Smooth cables: used both for buried lines, with or without sheaths depending on their composition, and for overhead installation, in gutters or in technical galleries.

III.4.5.2 Connections and junctions

Connections and junctions on buried LV networks are made using injected or cast plastic boxes, into which a cold-curing insulating resin is poured.

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III.4.5 3 Switching and protection devices

These are grouped together in permanently accessible outdoor boxes or cabinets.

III.4.6 Individual connections

House connections are the terminal parts of the public distribution network. They bring the electrical current to the boundary or inside the property being served, depending on whether they are individual or collective connections.

III.4.6.1 Individual connections

These serve a single delivery point and are made up as follows:

- Connection to the public distribution network ;
- The individual branch ;
- The meter, the general control and protection device and any control devices;
- Any remote control relay receiver (or clock), in the case of multiple tariffs;
- Any remote control circuits.
- Connection types

✓ **The overhead connection** is practically abandoned in urban areas; it is still used in rural areas when the network lines are overhead.

✓ **Overhead-underground connections** are found mainly in rural areas or in housing estates, where the service is provided by an overhead network.

✓ **Underground connections** are the most common type of connection, whether for a detached house, a multi-dwelling development or an industrial estate.

III.4.6.2 Collective connections

These serve several delivery points. They comprise the following components:

- Cables linking the connection point to the switch boxes on the front of the buildings;
- Switching and protection devices;
- Any remote-report circuits

III.4.6.3 Transformer substations

These are essential elements in the distribution of electrical current. Located in the center of the area to be connected, they are permanently accessible from a service road and designed to blend in with the surrounding environment. They are either built in the traditional way in the housing estate or housing development, or prefabricated and installed on a concrete slab. They

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can also be located inside buildings, in a specially designed technical room. In this case, it is imperative to ensure perfect acoustic insulation from neighboring premises.

III.4.7 The fuel gas distribution network

Gas is one of the least polluting and most economical energy sources when the development is close to an existing network. It meets a wide range of needs in the residential, commercial and industrial sectors.

III.4.8 Gas requirements

Gas is required for a number of purposes:

- Domestic use: cooking and hot water supply;
- Space heating ;
- Air conditioning;
- basic energy for industrial and craft applications.

III.4.8.1 Distributed gases

They come from a variety of sources:

Natural gases: of various origins: Lacq, North Sea, Algeria or Russia.

Manufactured gases: formerly known as town gas, are produced locally and are lighter than air.

Liquefied hydrocarbons: products of petroleum distillation. Classified in two categories: commercial butane and commercial propane, they are heavier than air.

III.4.8.2 Distribution pressure

Distribution pressure varies according to the type of gas and the points on the network. Natural gas is distributed under different pressures:

- low pressure < or equal to 0.005 MPa, corresponding to the pressure at which appliances are used.
- medium pressure A, between 0.005 MPa and 0.04 MPa, is the pressure admitted in connections and pipes serving buildings.

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- medium pressure B, between 0.04 MPa and 0.4 MPa, allows the use of pipes with reduced cross-sectional area.

III.4.8.3 Networks

They comprise the following elements: distribution pipes, collective or individual connections, pressure-reducing stations, shut-off devices and metering devices.

✓ **Distribution pipes**

These are the essential part of the network, as they carry the gas to the various points to be served.

✓ **Pipe materials**

The materials used for the pipes are :

Steel for main pipes, whether buried or elevated;

Polyethylene for supply and service pipes;

Copper is rarely used for buried pipes, given its cost.

✓ **Individual connections**

These are connected to the service pipes by a T or, more frequently, by a take-off device. They are controlled by a permanently accessible shut-off device. They comprise: the service pipe; a shut-off valve; a regulator and a meter.

III.4.9 Telecommunications network

Despite the development of mobile telephony, connection to the general fixed-line network is still the rule, given the many services provided: telephone, fax, telex, videoconferencing, Internet, etc.

III.4/9.1 The composition of the telephone network

The telephone network is made up of several components: a main distribution frame, transport, distribution and connection lines, distribution points, and terminal strips for connecting end stations (figure 3.5). It is built according to one of the following principles:

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1 The overhead network, which is virtually abandoned in urban areas, is particularly sensitive to wind and snow.

2 The technical gallery network is relatively uncommon, except in the case of commercial, hospital and industrial complexes....

3 Laying the network in a curb and gutter is an economical solution, but one that encounters a number of difficulties. On the one hand, during the construction phase, when coordination with other networks is required, and on the other hand, during the use phase, gutters cannot withstand overloading by heavy goods vehicles.

4 The underground network is the most common technique used in urban areas, with cables running in cable ducts.

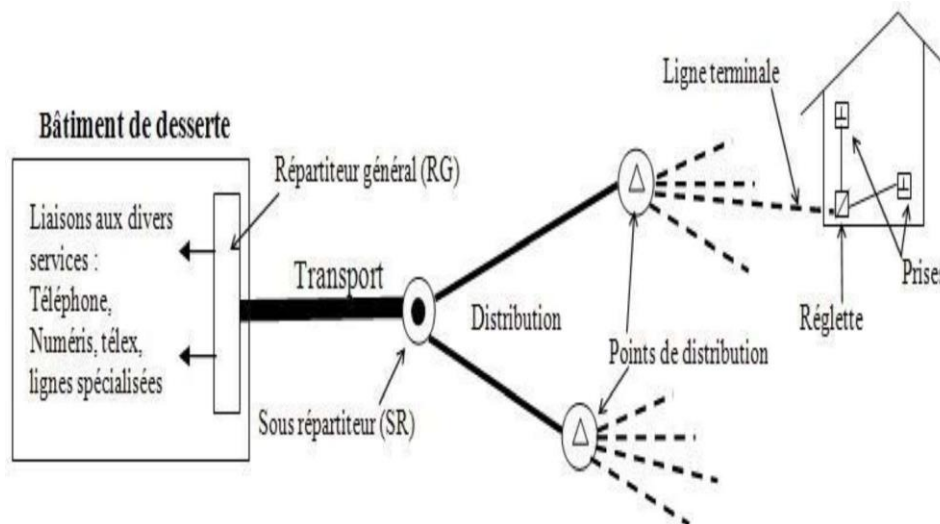


Figure 3.5: telephone network

III.4.9.2 The main distribution frame

Distributes transmission lines.

III.4.9.2.1 Sub-distributors

These are located at strategic points on the network, on the public domain, so as to be permanently accessible. They form the interface between the transmission lines and the distribution lines.

III.4.9.2.2 Pulling chambers

These are located at regular intervals or at specific points on the network (change of direction). They are located under sidewalks or on roadways.

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III.4.9.2.3 Jackets

These are rigid PVC tubes with a grey needle. Their number and diameter are adapted to the number of lines they are to contain, with provision for a reserve in the event of an expansion or change in demand.

III.4.10 Telephone lines

They use two techniques:

a. **Conductive metal** , with multipolar cables made up of insulated, twisted copper wires, assembled in pairs or fours, at low cost and easy to handle. This is the most common method used in telecommunications.

b. Or **coaxial cables**, which consist of a copper core around which a dielectric is successively laid, a metal braid forming the outer conductor and the light wave with optical fibers, which have a glass fiber core some ten microns thick.

III.4.10.1 Distribution points

These are judiciously placed to serve subscribers, and are made up as follows:

- a. Raised terminals made of reinforced concrete or polyester, in the immediate vicinity of a chamber and bordering the public roadway;
- b. By a derivation in the drawing chamber.

III.4.10.2 Terminal strips

These are the elements to which users are connected.

CHAPTER IV
GREEN
SPACES

IV.1 INTRODUCTION

The planning and management of green spaces are essential to the creation of public and private leisure areas. These spaces are created to humanize adaptation areas by balancing the mineral aspect of buildings, road surfaces and parking areas. Green spaces offer a variety of activities, from theme parks and botanical gardens to sports grounds and playgrounds. They also serve as places of relaxation and natural beauty for residents and visitors alike.

IV.2 Designing green spaces

The design of green spaces is studied by a landscape architect, taking into account the location of buildings, roads, the environment, the needs of users and the nature of the soil. He or she distributes the plants, associates the colors and looks for the arrangements best suited to the geographical situation, the nature of the soil and their integration into the landscape, while preserving, to the extent possible, existing trees and shrubs.

Plants are chosen to best match the desired landscaping adaptation:

- Integrate the adaptation area into its plant environment;
- Adapting the ground surface to create gardens, flowerbeds and lawns;
- Divide spaces with hedges of varying heights, using a single species or a mixture of species;
- Marking a driveway or lane with one or more rows of trees;
- Composing a bed of flowering or non-flowering shrubs.

Green spaces are often complemented by amenities for users: benches for resting, play areas for children, lighting, water features, etc.

IV.3 Green space components

Green spaces comprise at least two components: the substrate and the plants (figure 4.1).

IV.3.1 The substrate

This is made up of two superimposed media: topsoil and substrate.

IV.3.1.1 Topsoil: forms the surface layer of the natural ground. Its thickness varies between 10 and 50 cm. In green space adaptation, the minimum thickness of topsoil is 30 cm on all grassed surfaces.

CHAPTER IV: GREEN SPACES

IV.3.1.2 The substrate is the layer beneath the topsoil, in which plants find the elements they need to grow. Where the substrate is impermeable, a drainage system is installed.

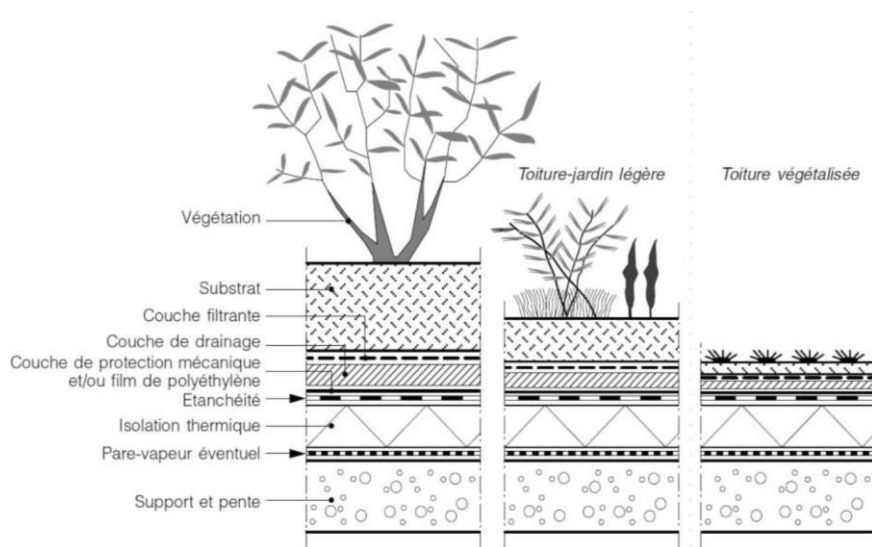


Figure 4.1 : Green spaces comprise

IV.3.2 The plants

They group together a large number of species which are used according to several parameters:

- Their own characteristics;
- The nature of the adaptation to be carried out;
- The nature of the soil;
- Climatic conditions;
- Exposure conditions.

Lawns, shrubs, trees and perennials are the essential components, with seasonal plants to accompany them in the creation of beds.

IV.3.4 Lawns

They form the base covering for green spaces, either to enhance other plants or for use as leisure areas, play areas or sports grounds.

IV.3.5 Trees and shrubs

They play a direct part in setting the scene for human activity and building construction.

CHAPTER IV: GREEN SPACES

The choice of shrub colors must comply with a few decorating rules, such as :

- Put dark colors in the foreground,
- Use tone-on-tone harmonies
- Avoid combining red and yellow
- Etc.

IV.3.6 Flowerbeds

It consists of a grouping of flowers of different varieties and colors planted on a regularly shaped surface of earth.

The different categories of flowers used are :

- Roses, with their many varieties, easy maintenance and abundant bloom,
- Annual flowers, which require staff to plant and maintain; they are pleasant but expensive,
- Hardy, long-lived perennials that can withstand normal winters and are planted in groups of 3 to 15 per m².
- Climbing plants, which cling to vertical elements by means of a light support; they grow easily and some can quickly cover a high fence or bare wall,

The ground must be well prepared: ordinary topsoil must be removed and replaced with a carefully measured mixture of fine soils. Planting generally takes place in winter, except during frosts and rainy periods.

IV.3.7 The hedges

Hedges are made up of shrubs planted in rows to form a continuous curtain varying in height from 1 to 3 m depending on the species chosen.

IV.4 Green space management

Managing green spaces is a complex task that requires meticulous attention to detail. A variety of skills are required, from technical aspects such as land adaptation and crop utilization, to knowledge of natural resource conservation.

Greenspace management also requires careful planning and consideration of environmental issues.

IV.5 Steps for managing green spaces

Needs analysis: Needs analysis is an important step in determining the objectives and functions of the green space.

It also helps identify necessary improvements and assess environmental aspects.

- **Planning:** Development planning is essential to ensure the coherence of green space management activities. This can include planting plans, maintenance procedures and risk assessments.

- **Plant management:** Plant selection, care and protection against pests are essential to effective greenspace management. It's also important to use plants that are adapted to the region.

- **Water management:** Good water management is essential for the successful management of green spaces. This can include controlling the use of irrigation, drainage and rainwater management systems.

- **Sustainable management:** Sustainable management is necessary to ensure the durability and conservation of green spaces.

This can include efficient use of natural resources, strategic planning and ongoing monitoring.

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