University of 8 May 1945 - Guelma
Department of Civil Engineering and Hydraulics

Notions on roads, railways and engineering structures

Master 1 : Geotechnics

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Organization of teaching

Unit: Discovery

Coefficient / Credit: 1 / 1

Number of teaching hours:

1h30 Course

Evaluation method:

Exam: 100%

Course content

Chapter I: Road concepts

Chapter II: Railways concepts

Chapter III: Bridges concepts

Chapter I: Road concepts

1. General

2. Traffic

3. The geometric parameters of layout of the raod

4. Development of intersections

5. Road pavements

1. General

- Importance of roads
- Road classification
- Road nomenclature
- Data to be considered in a project
- Concept of speed
- Stopping distance

Importance of roads

The road is the most important transport infrastructure:

- Facilitating commercial exchanges.
- Contributing to economic development by transporting raw materials and merchandise to industrial zones.
- Openning up rural areas and enable the delivery of the population's needs and facilitate their transport. This allows the development of these areas and decrease the rural exodus.
- Bringing cities and regions closer together, making it easier to transport people and merchandise.

Road classification

Classification criteria

- Practical and situational utility
- Administrative and legal order → In Algeria
- Constructive order
- Nature of traffic
- Functional order

Road Classification

Administrative and legal classification

(Highways, national roads, wilaya roads, communal roads)

1/ Main network (RP):

- RP Level 1 (RP1) : Traffic > 1500 Vehicles/day, connections between wilaya capitals - economic and strategic interest.

  Category 1 (Cat.1): Traffic > 4500 V/day

  Category 2 (Cat.2): 3000 < Traffic < 4500 V/day

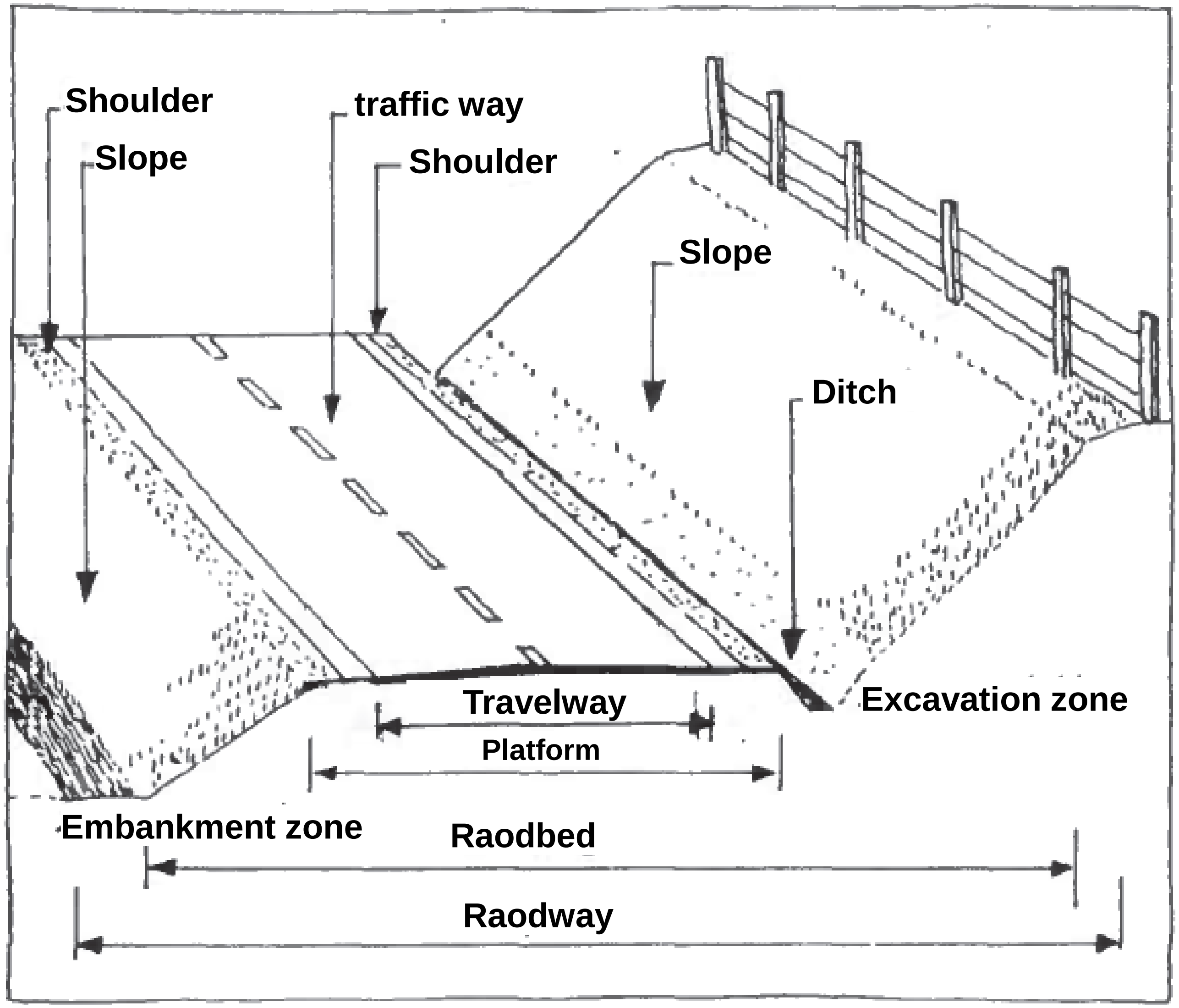
  Category 3 (Cat.3): 1500 < Traffic < 3000 V/day

- RP Level 2 (RP2) : Traffic < 1500 V/day, national roads and wilaya roads connecting Algeria with other neighboring countries (Cat.4)

2/ Secondary network (RS):

composed of the remaining roads not classified as RP1 and RP2 (Cat.5)

Road nomenclature



Data to consider in projects

The definition of the ***geometric characteristics*** of the road requires the prior choice of a certain number of basic data, the most essential of which are the following:

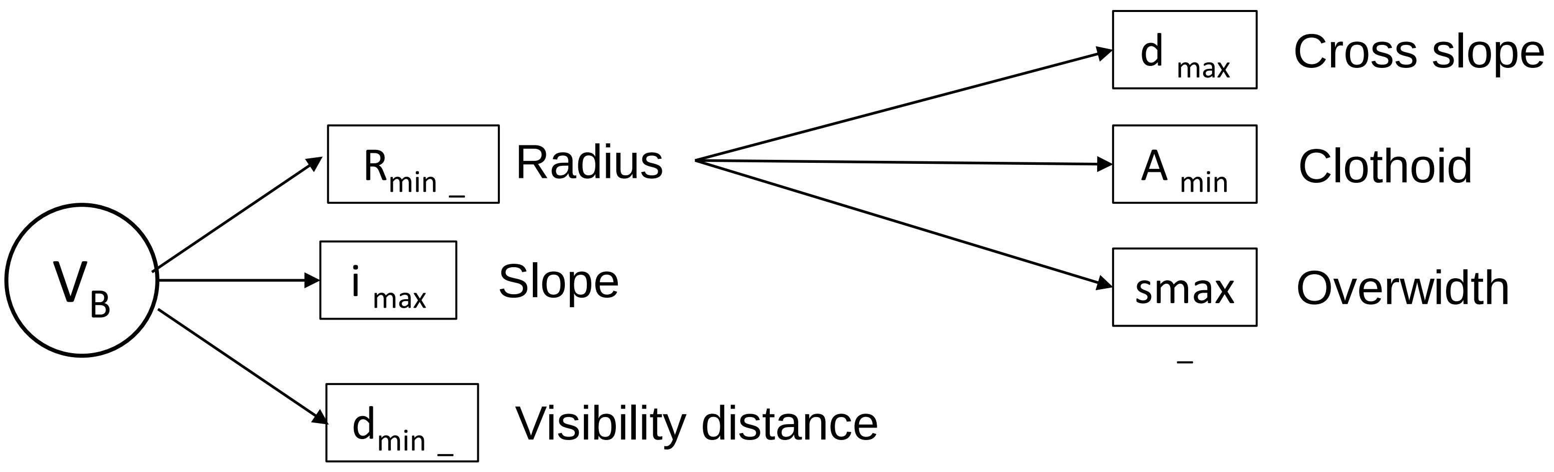
- traffic
- project speed
- Stopping, overtaking and visibility distances

Concept of speed

Basic speed V_B

Theoretical speed used to determine the extreme values of the geometric characteristics of road layout, it depends on:

- Road type
- Importance and type of traffic
- Topography
- Economic conditions



Concept of speed

Basic speed V_B (Technical Standards for Road Development B40 – Algeria)

Envi. / Category		Cat.1	Cat.2	Cat.3	Cat.4	Cat.5
E1 (Flat)	V_{vL}	120	120	120	100	80
	V_{pL}	40	40	35	30	-
E2 (Hilly)	V_{vL}	100	100	100	80	60
	V_{pL}	35	35	30	25	-
E3 (Mountainous)	V_{vL}	80	80	80	60	40
	V_{pL}	30	30	25	20	-

Concept of speed

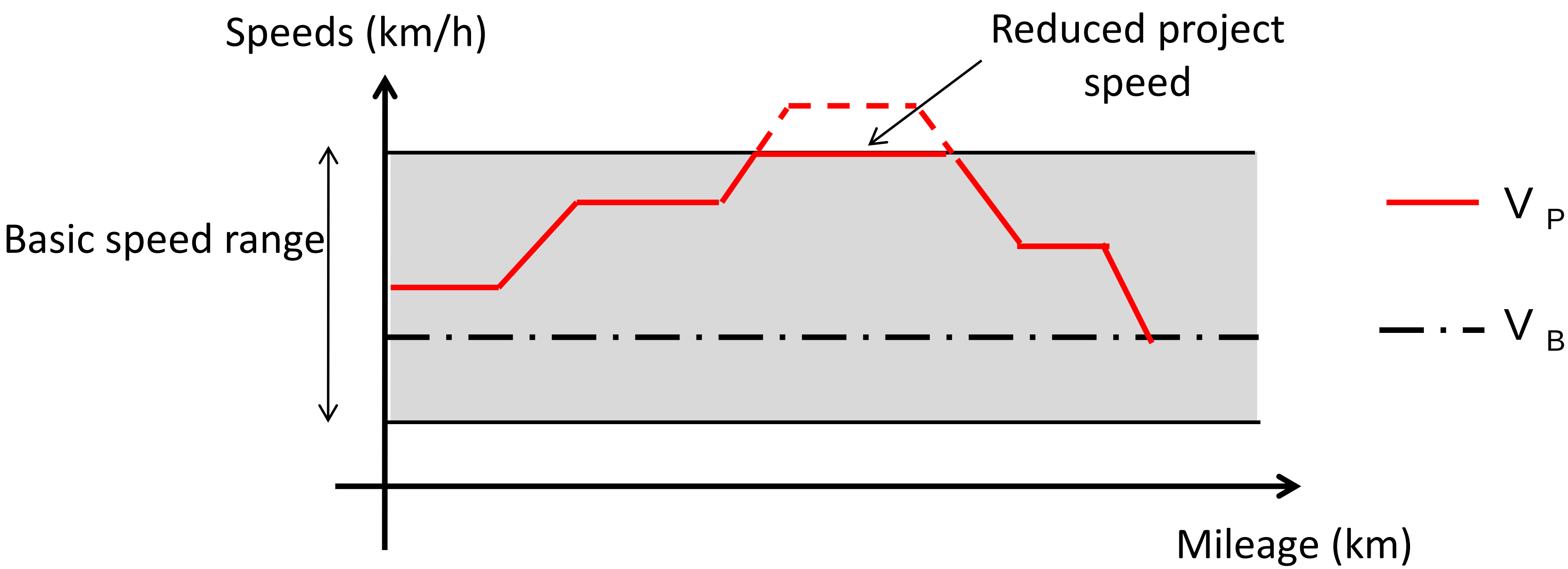
Basic speed V_B (Example of some countries)

Country	Road type	V_B (km/h)
Swiss	High-volume roads Main roads Collector roads	80 – 120 60 – 120 50 – 80
France	Highways Highways + very uneven terrain Ordinary roads + little uneven terrain Ordinary roads + uneven terrain	130 100 100 80
Italy	Milan – Bologna Bologna – Florence Florence – Rome	150 100 120

Concept of speed

Project speed V_P

Highest speed that can be allowed at each point of the road.



Stopping distance

This is the theoretical distance necessary for a vehicle to stop, it is equal to:

$d_2 = d_1 + 0.25\, d_0$ if $R \leq 5\,V$

$d_2 = d_1$ if $R > 5\,V$

d_0 : reaction perception distance in (m)

d_1 : braking distance in (m)

d_2 : stopping distance in (m)

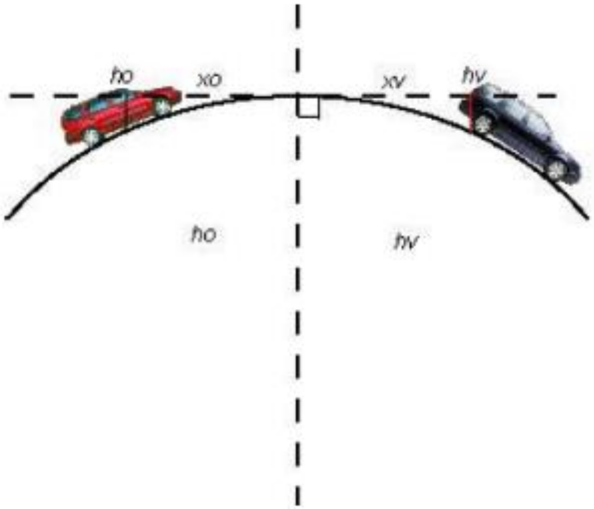
R: radius in plan in (m)

V: speed in (Km/h)

Stopping distance

Reaction perception distance (d_0) in (m)

$$d_0 = \frac{V^2}{254 \cdot (f_L \pm i)}$$



V: speed in (Km/h)

f_L : friction coefficient (average $f_L = 0.40$)

i (%): the slope (+) ramp, (-) slope

Braking distance (d_1) in (m)

$$d_1 = \frac{2 \cdot V}{3{,}6} + \frac{V^2}{254 \cdot (f_L \pm i)}$$

2. Traffic

- Some statistics
- Different types of traffic
- Traffic composition: Counts
- Traffic indicators
- Calculation of the number of channels

Some statistics

Statistics from 2011:

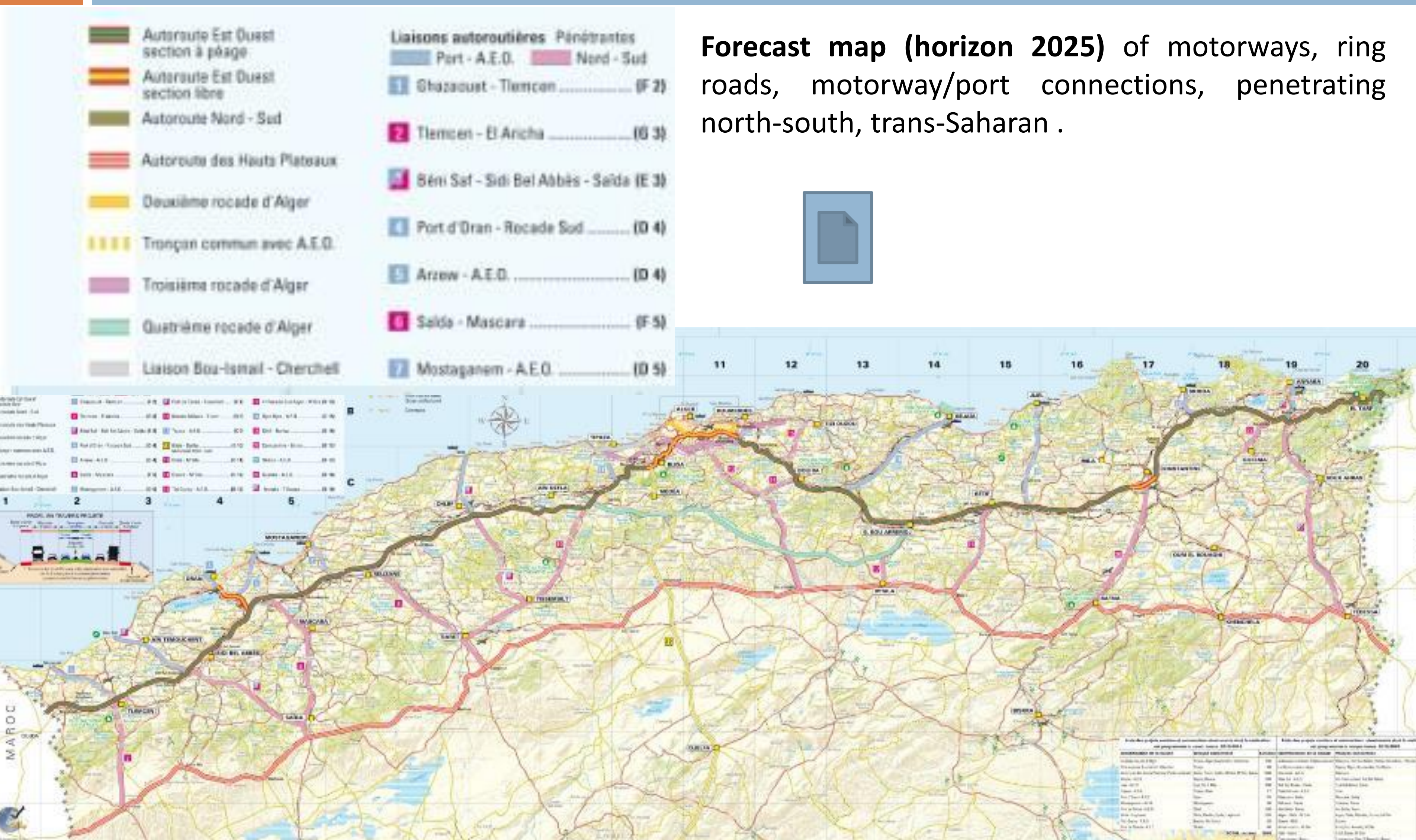
- National automobile fleet > **6 million** vehicles (300 thousand new vehicles/year)

- **112,696 km** of roads providing nearly 90% of the volume of trade, this shows the importance of the road transport mode compared to other modes (rail, air, maritime)

- Highways 1216 Km, National Roads (RN) 29,280 Km, Wilaya Roads (CW) 23,771 Km, Communal Roads (CC) 59,645 Km **,** Works of Art (OA) 4910 Unit

Some statistics

Forecast map (horizon 2025) of motorways, ring roads, motorway/port connections, penetrating north-south, trans-Saharan .



Different types of traffic

- ## Transit traffic:

Origin and destination outside the study area.

(important for deciding on the need for a diversion)

- ## Exchange traffic:

Origin within the zone studied and destination outside the exchange zone and vice versa.

(important for defining exchange points)

- ## Local traffic:

Internal which moves within the studied area.

Traffic composition

The counts:

- Automatic counts

- permanent or temporary

- Created for the most important roads (motorways, RN, RW)

- Disadvantage: impossibility of differentiating between VL and PL

- Manual counts

- Complementary tool for automatic counts (%PL)

- Provides information on directional movements in an intersection

Traffic indicators

- **Annual Average Daily Traffic (ADT)**

Total traffic for the year / number of days (*vehicles/day*)

- **Traffic at a given horizon (ADT_h)**

Gives an indication of annual traffic growth.

- $TJMA_0$: Traffic in year *0*
- $TJMA_h$: Traffic for the year horizon " *h* "

$$TJMA_h = (1 + \tau)^n \, TJMA_0$$

τ : the annual growth rate of traffic

n: number of years

Traffic indicators

Effective traffic (T_{eff})

Traffic translated into passenger vehicle units (*PVU*) based on road type and environment.

Convert "PL" into " *uvp* " → equivalence coefficient " *p* "

$$T_{eff} = [(1 - z) + pz]\ TJMA_h$$

T_{eff} : effective traffic at horizon h, expressed in (*uvp /day*)

z : % heavyweight; *p* : equivalence coefficient (table below)

Roads	E1: easy (plain)	E2: medium (hilly)	E3 : difficult (mountainous)
2 lanes	3	6	12
3 ways	2.5	5	10
4 channels and more	2	4	8

Calculation of the number of channels

Capacity request

Number of vehicles likely to use the road over the next year. We take *the normal hourly peak flow (uvp /h)* :

$$Q = 0.12\ T_{rms}$$

Evaluation of the offer:

The supply is *the admissible flow* that a road can support:

$$Q_{adm} = K_1 K_2 \text{ Theoretical capacity}$$

K_1 : coefficient depending on the road environment

K_2 : coefficient depending on the category and the environment of the road

Calculation of the number of channels

- Evaluation of the offer:

Environment	E1	E2	E3
Values K1 _	0.75	0.85	0.95

K_2 values					
Environment	Cat.1	Cat.2	Cat.3	Cat.4	Cat.5
E1	1	1	1	1	1
E2	0.99	0.99	0.99	0.98	0.98
E3	0.91	0.95	0.97	0.98	0.98

Calculation of the number of channels

- Evaluation of the offer:

Theoretical capacity takes the average values below:

- 2 lane road of 3.5 m: 1500 - *2000 uvp /h*

- 3.5 m 3-lane road: 2400 - *3200 uvp /h*

- Divided road: 1500 - *1800 uvp /h/direction*

Calculation of the number of channels

Calculation of the number of channels:

➢ Two-way roadway

We compare Q to Q_{adm} for different types of roads and we deduce the number of lanes allowing us to have:

$$Q \leq Q_{adm}$$

➢ Unidirectional roadway

$$n = 2Q/3Q_{adm}$$

n: is the number of lanes per roadway (whole number)

Example

A count carried out for a category 1 road (2 lanes) to give a TJMA = 10,500 v/d with 20% heavy goods vehicle (LP). This road is located in an E2 environment. You are asked to:

1/ Calculate the effective traffic " T_{eff} " in the 12th year of commissioning knowing that the annual growth rate τ = 4%

2/ Calculate the number of lanes to give to the road at this time horizon.

3. Geometric parameters

- Introduction
- Plan layout
- Long profile
- Cross profile

Introduction

The road is defined geometrically by three groups of elements:

- Plot of its axis in plan (plan plot)
- Plot of this axis in elevation (long profile)
- Cross profile

The geometric characteristics of this layout must satisfy criteria:

- Economic and strategic
- Topographic and geological
- Expected future traffic

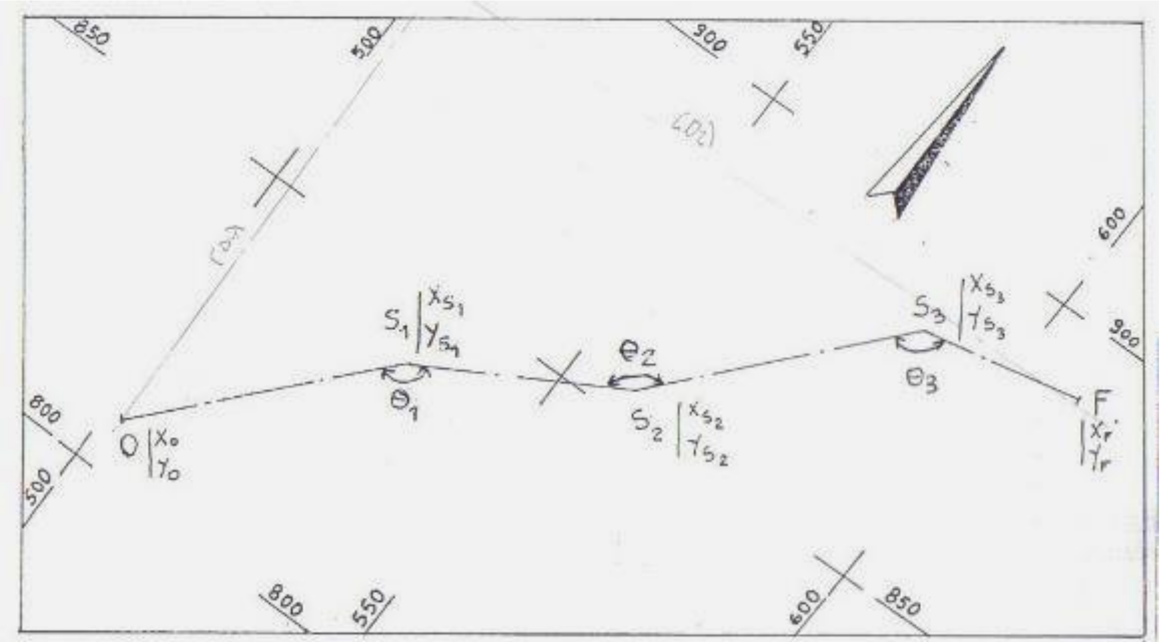
Plan layout

The layout of a road is a top view , it is a succession of:

- Straight (Alignments)

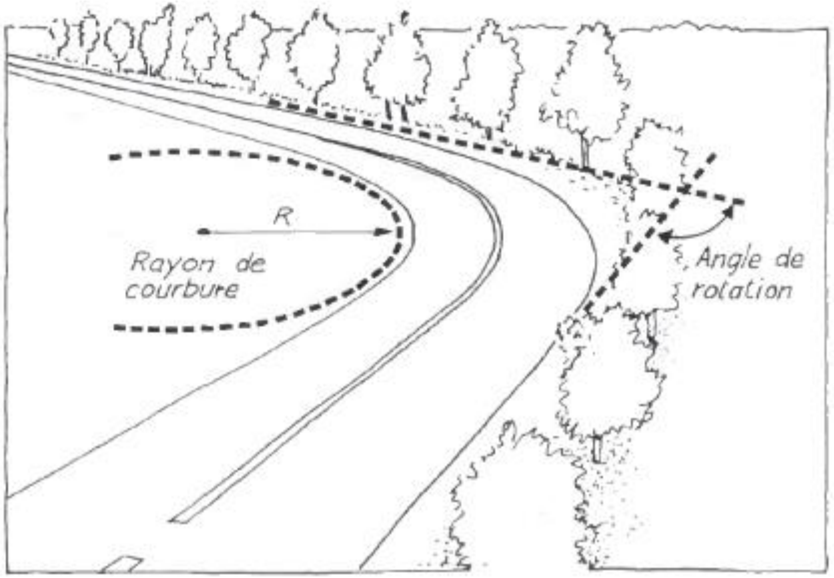
- Circle arcs

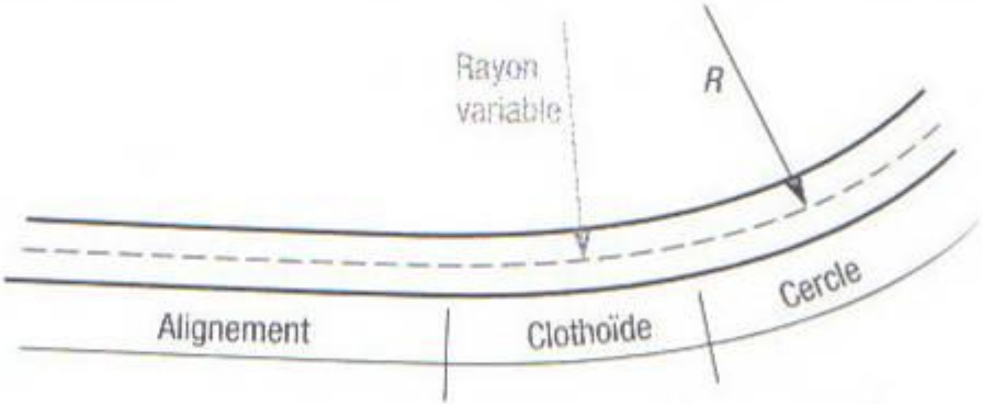
- Connection curves (Clothoid)



Plan layout

Geometric parameters





Plan layout

a/ The Alignments

The inconvenients :

- Prolonged glare of headlights at night
- Constant driving difficulties (fatigue $\rightarrow$ accidents)
- Difficult assessment of distances between vehicles

The length of the alignments depends on:

- the basic speed V_B
- previous and next radius

Plan layout

a/ The Alignments

The concept of length minimum and maximum :

$$L_{min} = 5 \cdot \frac{V_B}{3{,}6}$$

$$L_{max} = 60 \cdot \frac{V_B}{3{,}6}$$

V_B : basic speed in (Km/h)

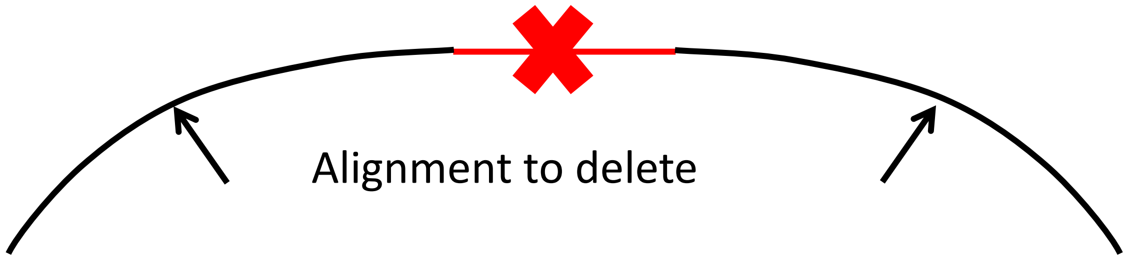
L_{min} and L_{max} : minimum and maximum length in (m)

Plan layout

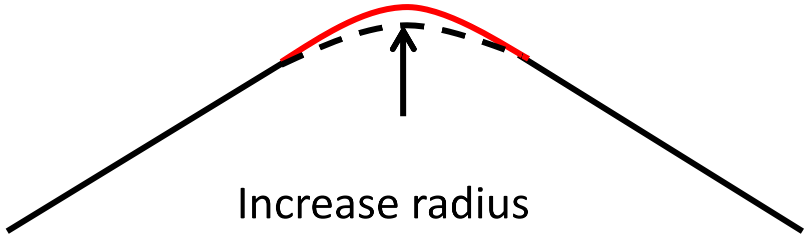
a/ The Alignments

For security reasons, the following special cases should be avoided:

- Meeting of 2 long curves by a short alignment



- Meeting of 2 long alignments via a curve



Plan layout

b/ The arcs of a circle

The choice of radius "R" must take into account the 3 criteria:

- Stability of vehicles in curves
- Registration of long vehicles in severe bends
- Visibility in curves

b.1) Stability: for a vehicle to remain stable in a turn it is necessary that:

$$R \geq \frac{V_B^2}{127\left(f_L + d\right)}$$

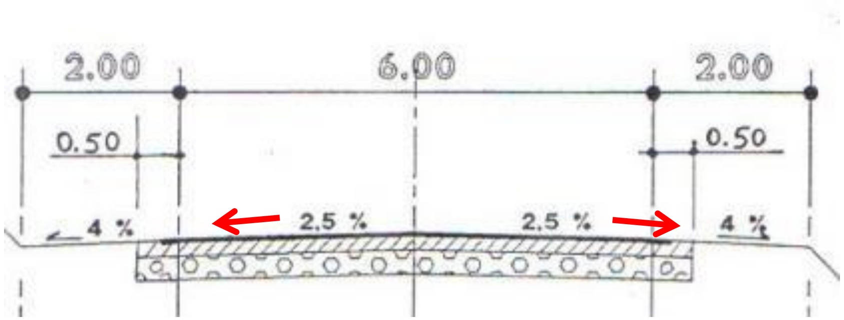
R: radius of the arc of the circle in (m) V_B: basic speed in (Km/h)

d (%): slope

Plan layout

b/ The arcs of a circle

Cant Values



Category	Environment	Slope (%)	
		Max	Min
1 - 2	1 - 2 - 3	5	2.5
3 - 4	1 - 2	6	3
3 - 4	3	5	3
5	1 - 2 - 3	6	3

Plan layout

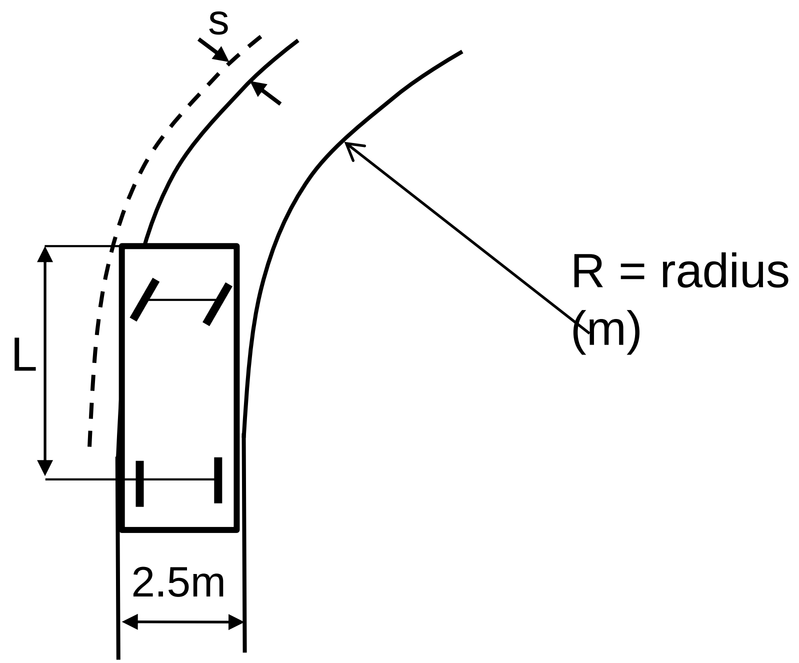
b/ The arcs of a circle

b.2) Overwidth (long vehicles)

$$s = \frac{50}{R}$$

s: excess width per lane in (m)

Only when R < 200 m

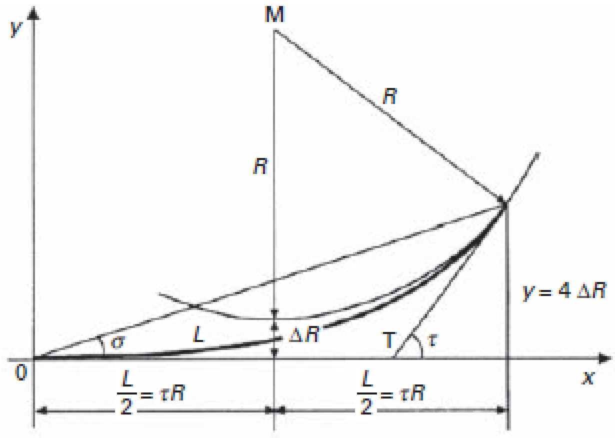


Plan layout

c/ The connection curves (Clothoids)

Why do we use CRs?

- Transversal stability of vehicles
- Comfort of vehicle passengers
- Gradual transition of the shape of the roadway (slc



$$\tau = \frac{L}{2R} = \frac{L^2}{2A^2} = \frac{A^2}{2A^2}$$

Si $\tau \leq 0{,}1$ rad:

$x = L$ à moind de 1/1 000 près
$y = L^2 / 6R$ à moins de 1 /1 000 près
$\tau = 3\,\sigma$ à moins de 1/100 000 près
$\Delta R = L^2 / 24R$

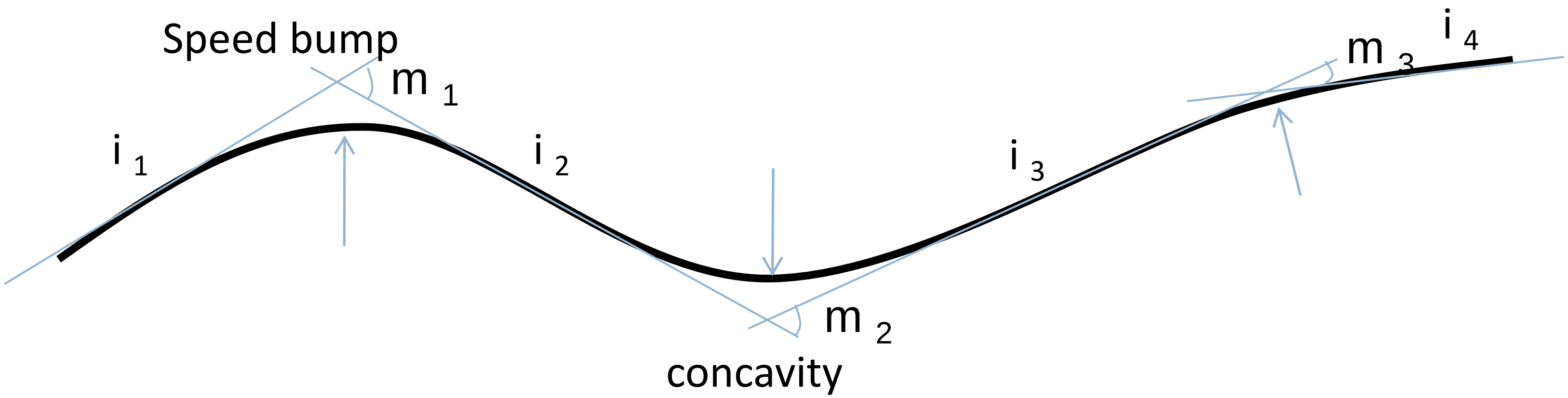
avec A paramètre tel que $A^2 = RL$
L longueur de la courte de raccordement
R rayon minimal de courbure du virage
τ angle de changement de direction

General equation:

$$A^2 = LR$$

Long profile

The longitudinal profile is a vertical section passing through the axis of the road, represented on a plan at a certain scale.



These geometric elements are:

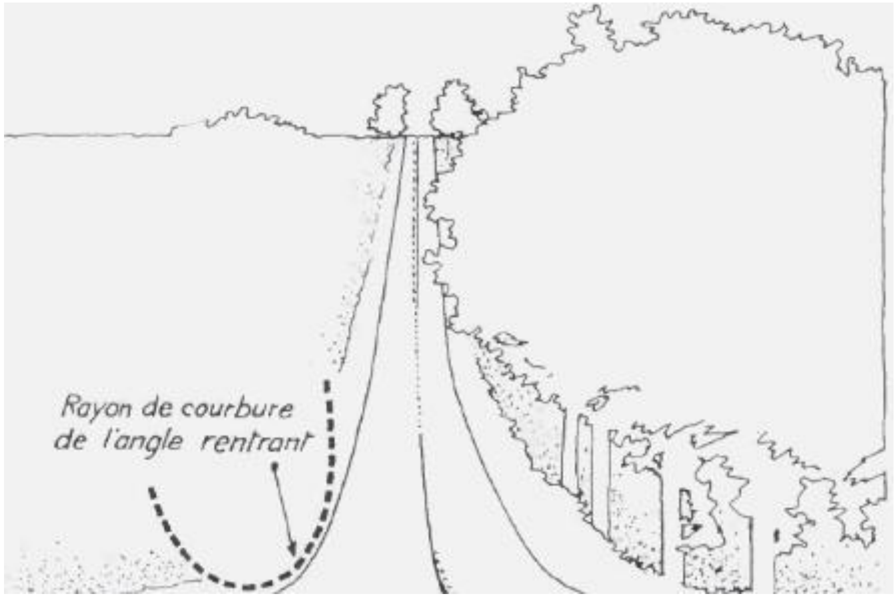
- Straight lines (slopes)

- Arcs of circles tangent to straight lines (convex and concave)

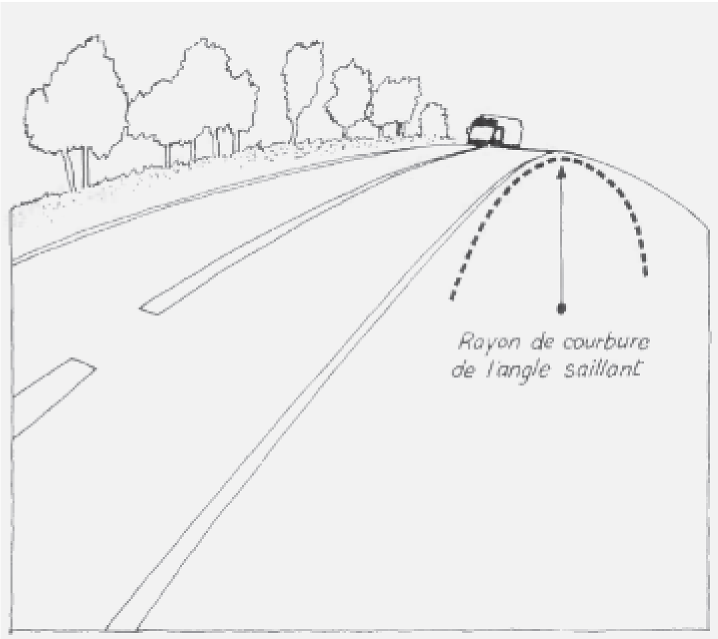
Long profile

Slope (ramp and slope)

Ascending lines “Ramp”, i (+)

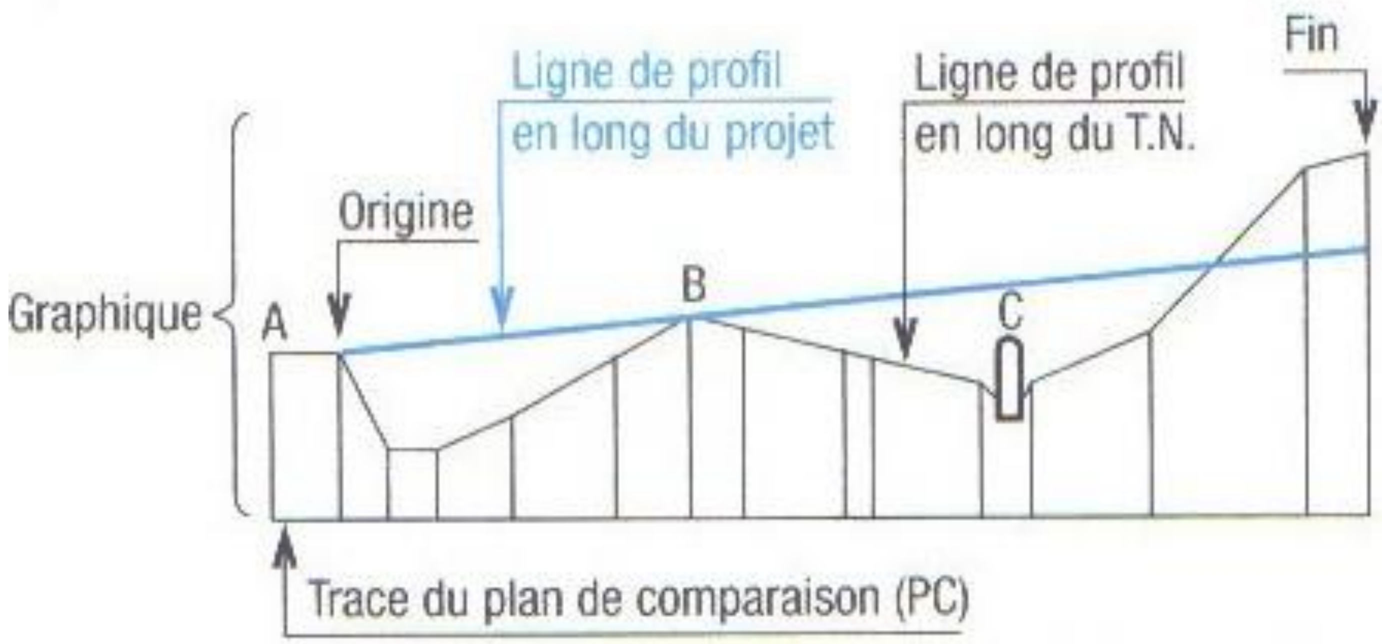


Descending lines “slope”, i (-)



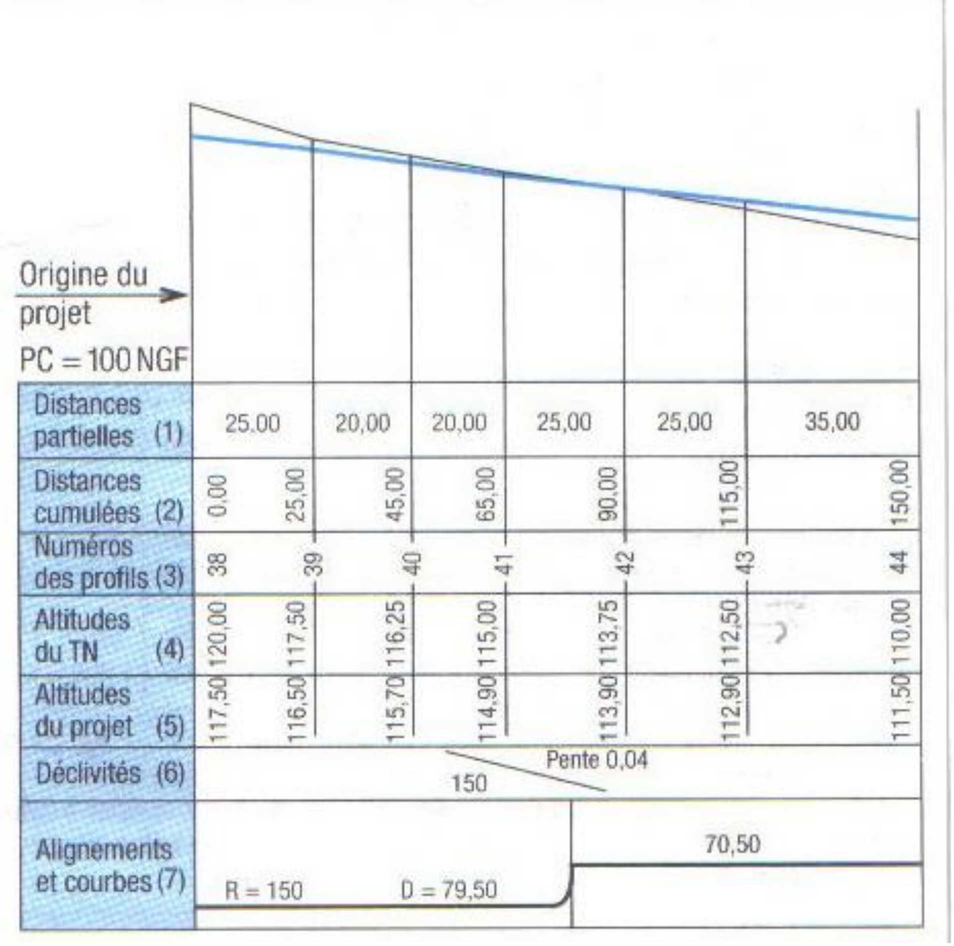
Long profile

Example of a long profile



Long profile

Example of a detailed longitudinal profile



Long profile

Design rules

Gradients:

- minimum slope: $i_{min} = 1\%$

- maximum length: [1.5 – 2 Km]

- maximum slope (i_{max}) depends on V_B (table below)

V_B (Km/h)	40	60	80	100	120	140
i_{max} (%)	8	7	6	5	4	4

Long profile

Design rules

- Convex vertical connections

The convex vertical radius " R_v " must satisfy two conditions:

- Comfort condition
- Visibility condition

$$R_{v\,min} = 0.3\,V^2_{B} \rightarrow (Cat.\ 1-2)$$

$$R_{v\,min} = 0.23\,V^2_{B} \rightarrow (Cat.\ 3-4-5)$$

Long profile

Design rules

➢Concave vertical connections

The concave vertical radius " R'_V " must satisfy the visibility conditions day and night (glare from headlights)

$$R'_V = \frac{d_1^2}{0{,}035 \cdot d_1 + 1{,}5}$$

d_1 : braking distance (on a slope)

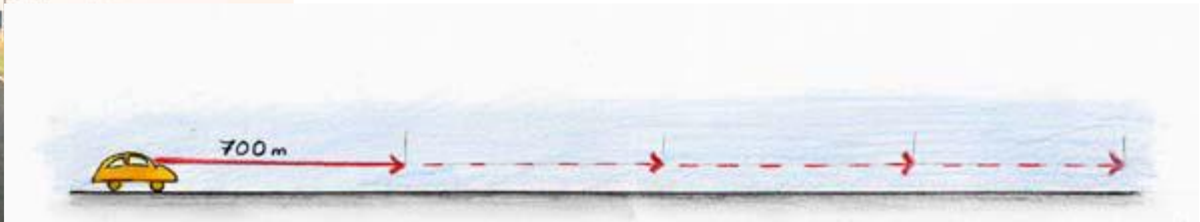
Plot in space

Coordinations plotted in plan - longitudinal profile

Concept of loss of trace

A bad combination between the plan layout and the longitudinal profile leads to a loss of layout.

No loss of trace

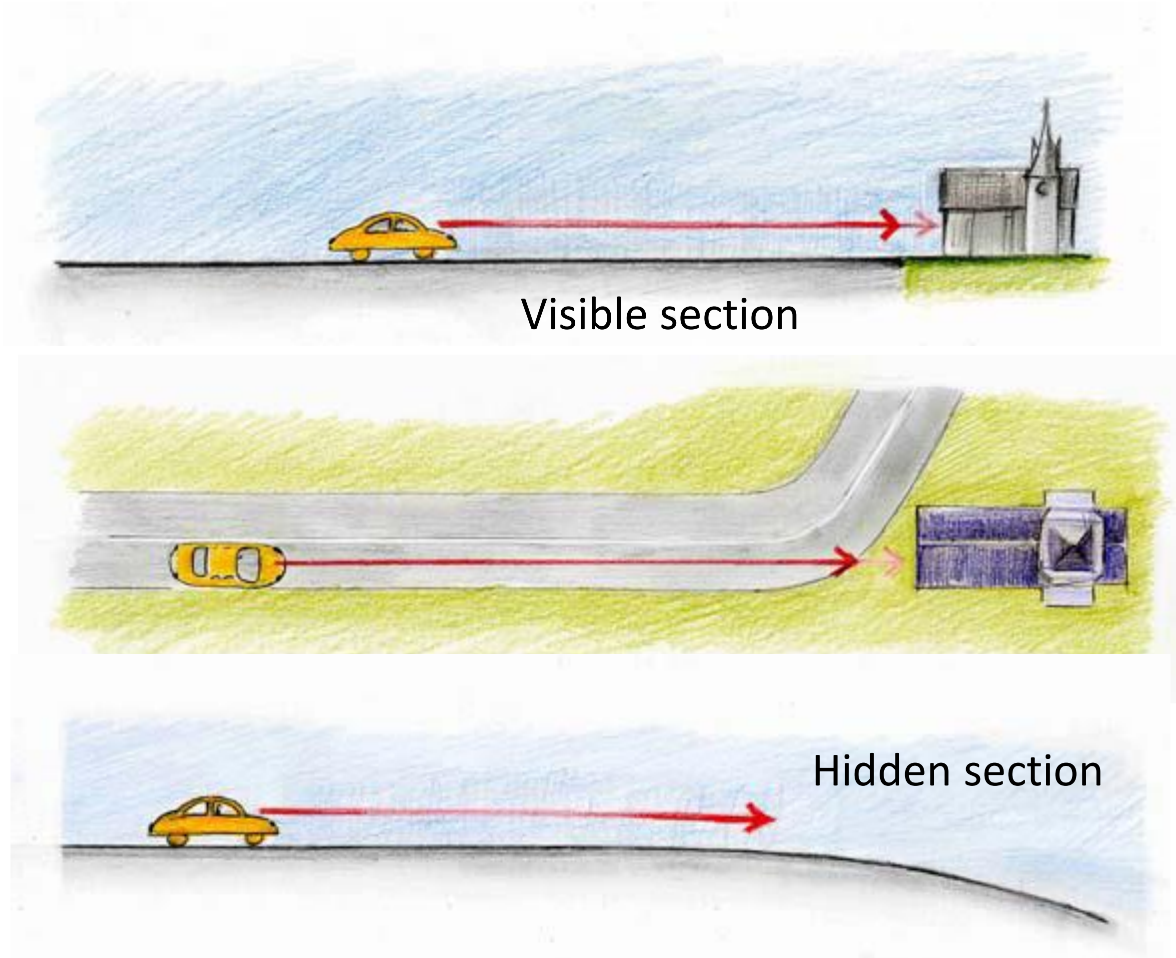


Visible sections

Plot in space

Coordinations plotted in plan - longitudinal profile

Concept of loss of trace



Loss of track

Plot in space
Coordinations plotted in plan - longitudinal profile

Rules to follow to avoid loss of track

1. Avoid the start of the turn ($R_h < 300m$) being located at the top point of the longitudinal profile

Plot in space

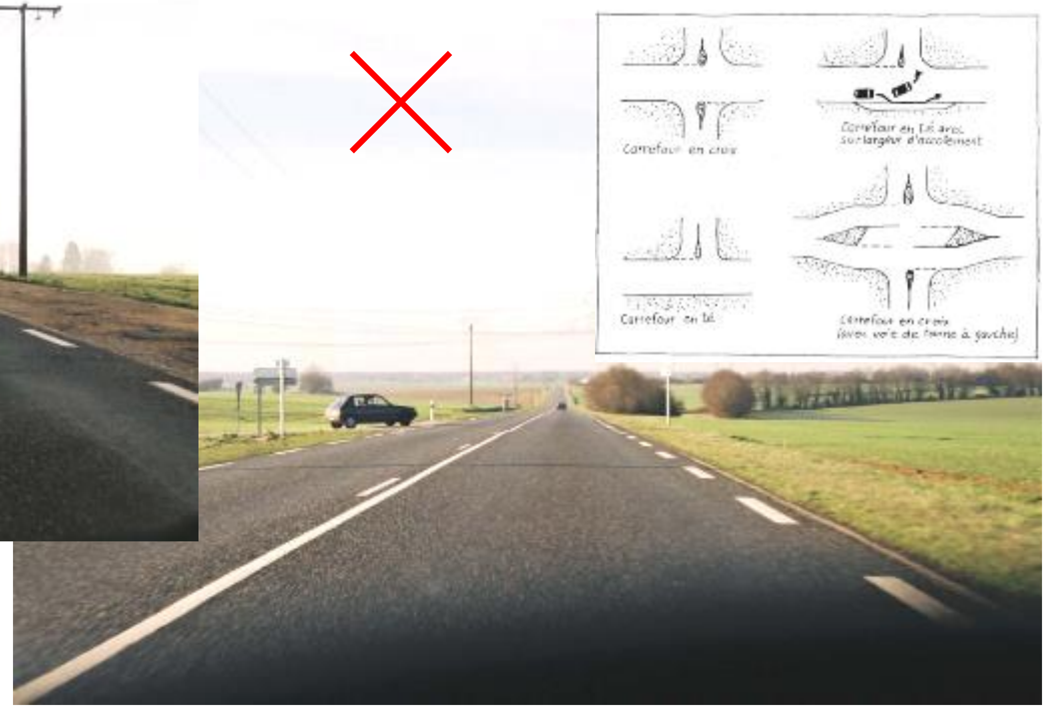
Coordinations plotted in plan - longitudinal profile

Adopt this type of solution:

Plot in space
Coordinations plotted in plan - longitudinal profile

Rules to follow to avoid loss of track

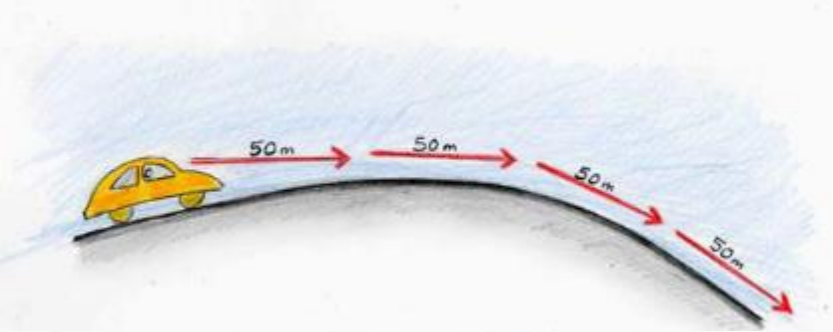
2. Avoid positioning crossroads or access points at a high longitudinal profile or in a zone of reduced visibility

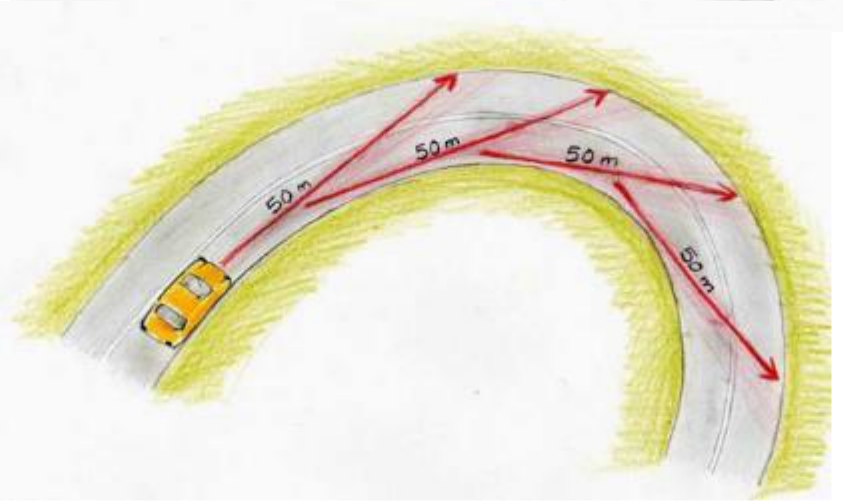


Plot in space
Coordinations plotted in plan - longitudinal profile

Rules to follow to avoid loss of track:

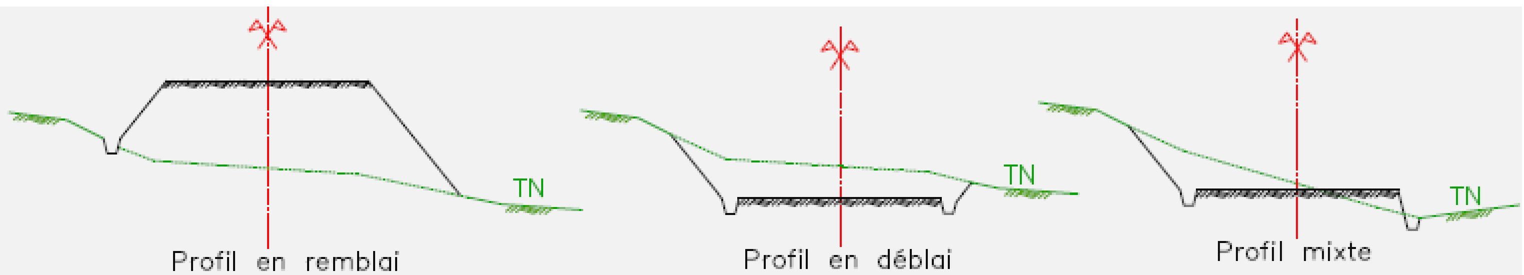
3. Match the curves of the plan layout with those of the longitudinal profile, trying to respect: $R_v > 6 R_h$ (R_h : radius in plan)





Cross Profiles

The cross sections are a vertical section of the road perpendicular to the alignment axis.



Différents types de profil

The cross sections make it possible to calculate:

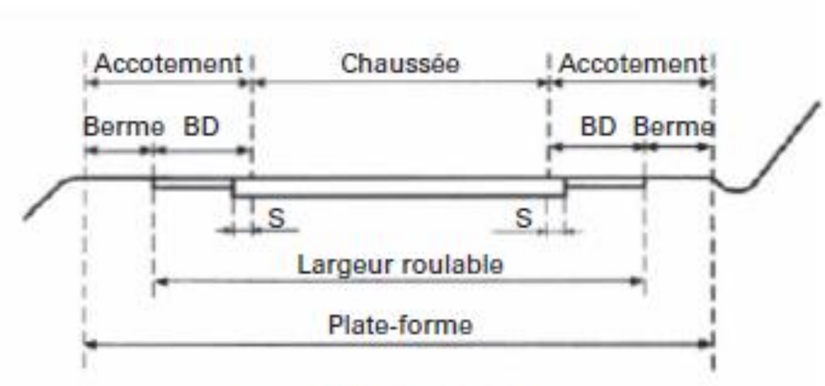
- The position of the theoretical earthwork entry points

- The layout of the route and its extent

- Cubatures (volumes of cut and fill)

Cross Profile

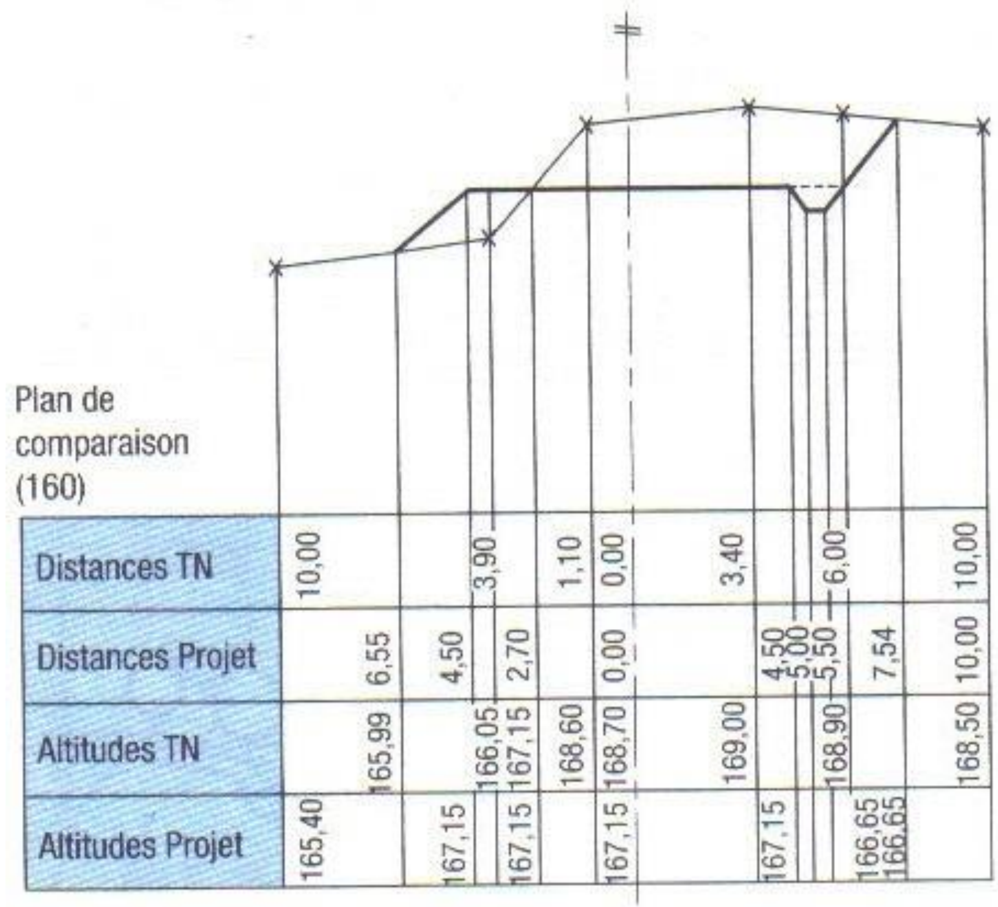
Detailed cross section



(b) route à 2 ou 3 voies

S Surlargeur (structurelle) de chaussée

BD Bande dérasé

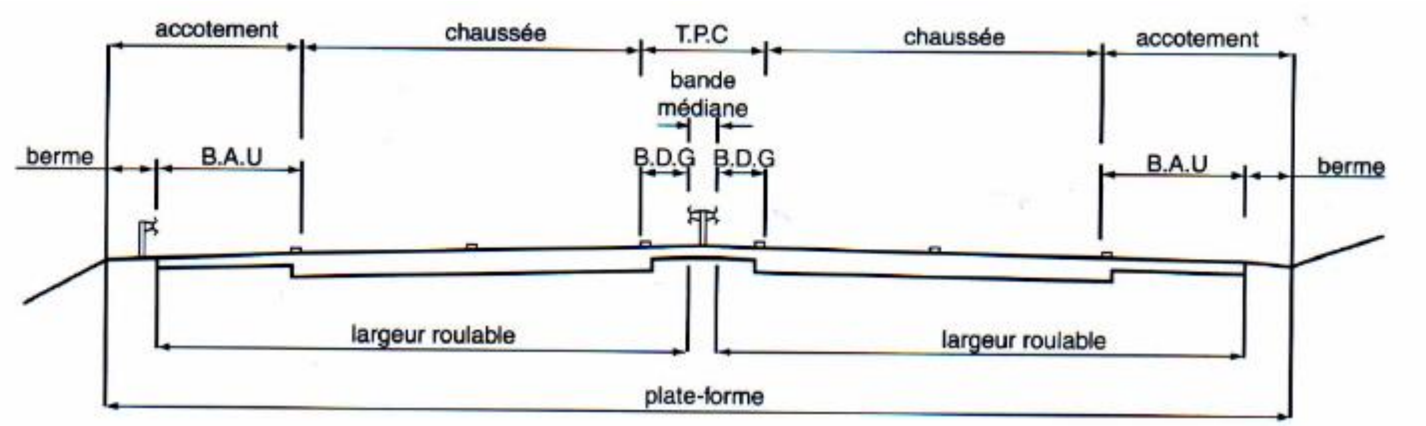


Cross Profile

Number of channels (Depending on traffic)

- Highways (2 × 2 lanes and more)

- Main roads 2 to 3 lanes or 2 × 2 lanes



BAU Bande d'arrêt d'urgence BDG Bande dérasée de gauche TPC Terre-plein central

Lane width: Is 3.5m international standard, it can be reduced to 3m in case of site constraints or when traffic is low.

4. Layout of intersections

- General
- Choice of intersection type
- Ordinary flat intersections
- Flat roundabout intersections
- Uneven intersections

General 1/1

Crossroads are the scene of many ***accidents*** . The aim of the development of intersections is to ***reduce*** this ***insecurity*** .

The design of the type of development to be retained is based on an approach which includes the following two stages:

- determination of a range of possible ***arrangements*** taking into account the development objectives of the axis, depending in particular on the ***type of road*** ;
- choice of the ***type of intersection*** within this range, depending on site characteristics (traffic, topography, security, environment, etc.) by means of a ***multi-criteria analysis*** taking into account safety, passage time, financial cost, etc.

Choice of intersection type 1/1

There are two main families of intersections:

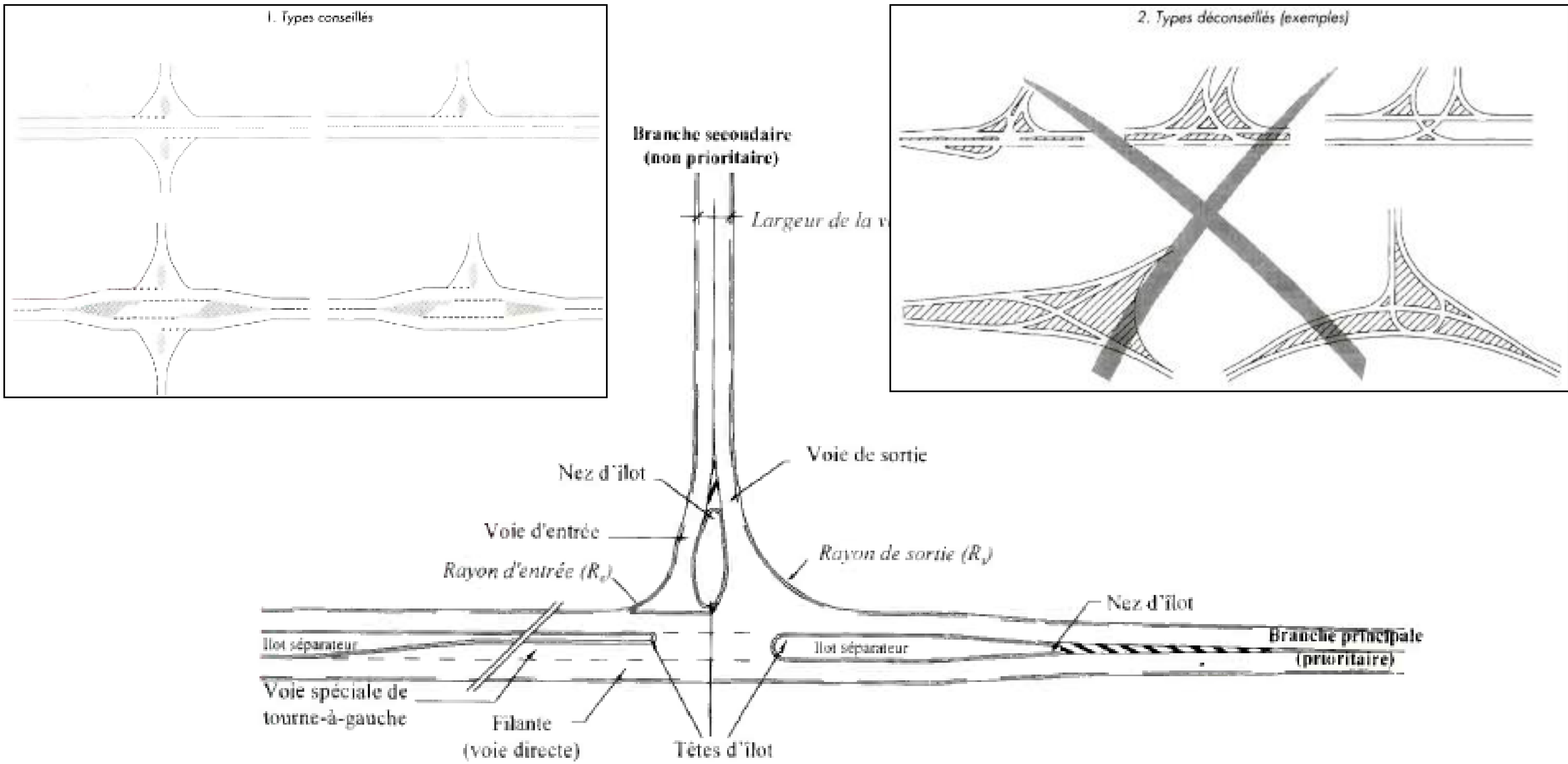
- ***Flat intersections*** or at ***-grade intersections*** which group together in the same plan all the exchanges between the roads concerned (ordinary, roundabouts).
- ***Grade-separated intersections*** or interchanges ***whose*** exchanges are separated from each other and managed outside the main axes.

The main criteria for choosing between these different crossroads are:

- ***safety:*** grade-separated intersections offer the best safety. The roundabout always presents a better level of safety than an ordinary level intersection.
- ***the cost:*** ordinary flat intersections are the least expensive than roundabouts. Grade-separated intersections are more expensive than level intersections.
- ***Lost time:*** This criterion is important on routes where long or medium distance traffic circulates (traffic-related delay, geometric delay).
- ***Overall coherence of developments along the axis:*** excessive frequency of roundabouts on the same route can become annoying for important roads.

Ordinary flat intersections 1/6

➢ **Main elements and parameters of an ordinary plane intersection**



Ordinary flat intersections 2/6

➢Conditions for establishing intersections

Visibility , readability, the distance between two intersections, and the limitation of the number of intersections installed.

Visibility distance = V $_{85}$ x crossing time

V $_{85}$: the speed below which 85% of users travel in smooth traffic conditions. It depends on the number and width of the lanes, plan radius, slopes)

This visibility distance makes it possible to construct the ***visibility triangle*** .

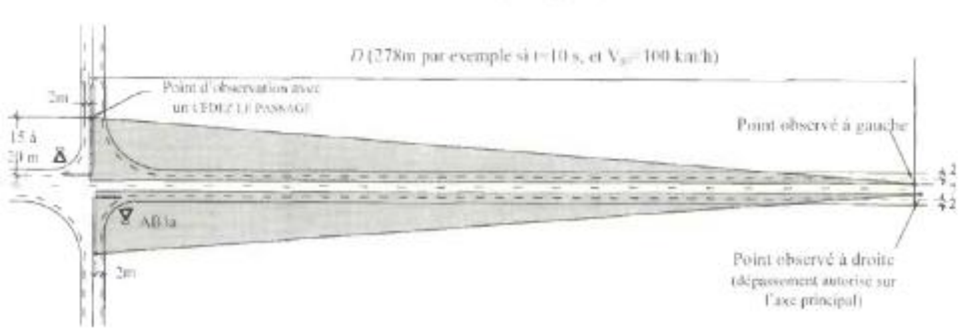
Profil en travers de la route principale		2 voies	2 voies + voie de T.A.G.	2 x 2 voies : insertion à droite dans les demi-carrefours
STOP	temps conseillé	8 s	9 s	8 s
	minimum absolu	6 s	7 s	6 s
CEDEZ LE PASSAGE	temps conseillé	10 s	11 s	9 s
	minimum absolu	8 s	9 s	7 s
Tourne-à-gauche vers la voie secondaire	temps conseillé	8 s		
	minimum absolu	6 s		

Ordinary flat intersections 3/6

➢Conditions for establishing intersections

Construction of the ***visibility triangle*** .

Situation de cédez le passage (panneau AB3a)



Situation d'arrêt (panneau STOP)

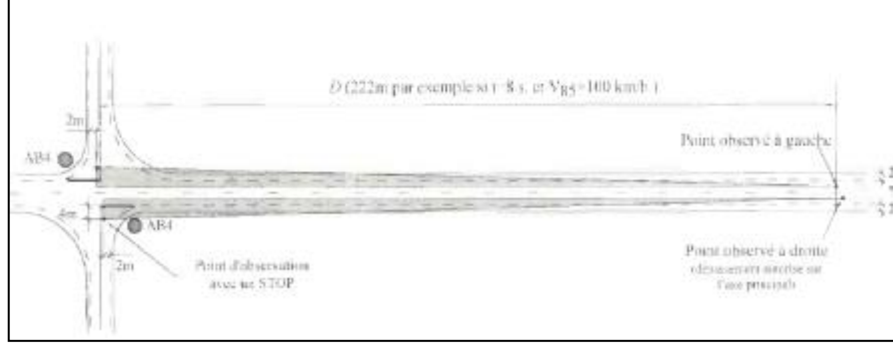
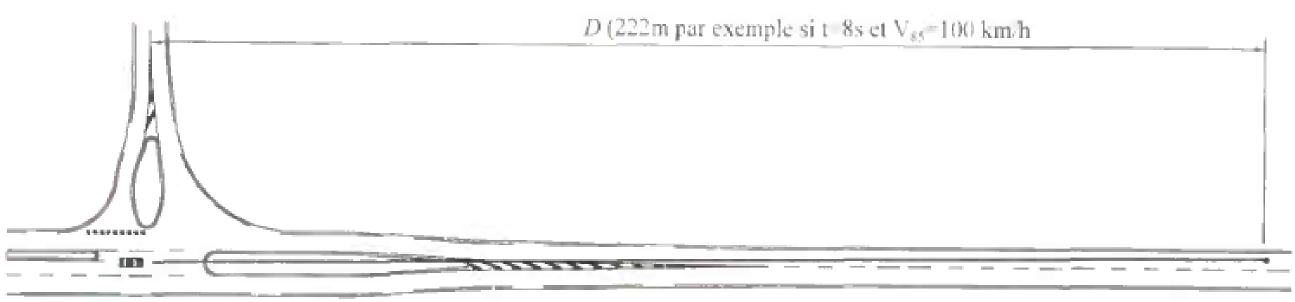


Fig. 5 — Condition de visibilité pour la manoeuvre de tourne-à-gauche vers la route secondaire.



Ordinary flat intersections 4/6

➢Conditions for establishing intersections

Visibility, **readability** , **the distance between two intersections** , and the limitation of the number of intersections installed.

Fig. 6 — Visualisation de la route secondaire intersectée par un alignement transversal.

Fig. 7 — Ecran végétal en blocage de la vision sur la branche secondaire d'un carrefour en té.

Tableau 2 — Distance minimale conseillée entre deux carrefours successifs aménagés, et possibilité de dépassement résiduelle[13], selon les vitesses pratiquées.

V_{85} (en km/h)	**60 - 70**	**80 - 90**	**100 - 110**
Distance minimale conseillée (en m)	600	900	1200
Possibilité de dépassement offerte (en m)	300	450	600

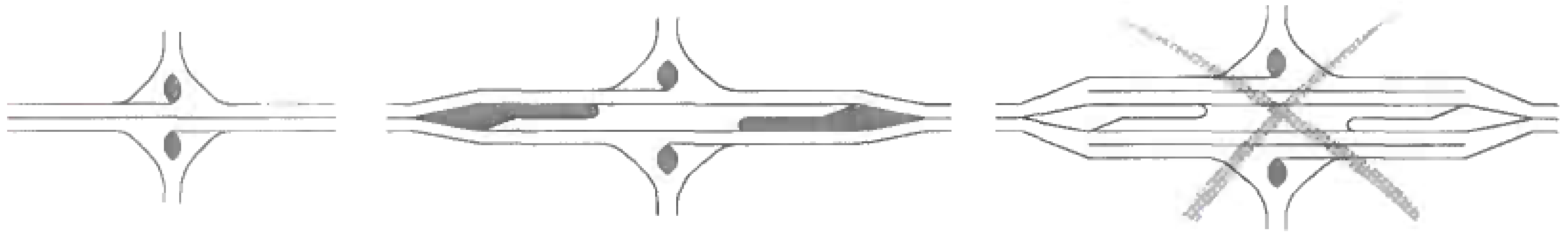
Ordinary flat intersections 5/6

➢Plan layout of the main branch

At intersections and for safety reasons, the number of direct lanes per direction of the main branch must be limited.

In the case of a ***2-lane road*** , only one lane must be maintained for each direction of traffic.

Fig. 8 — Principe d'aménagement des carrefours sur les routes à 2 voies en section courante.

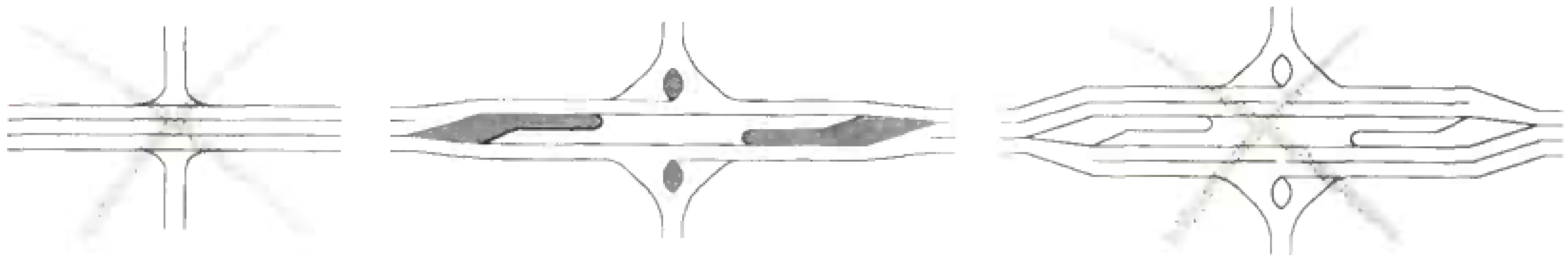


Ordinary flat intersections 6/6

➢Plan layout of the main branch

In the case of a ***3-lane road*** , maintaining it at ordinary crossroads is ***strongly discouraged*** . Under these conditions, one-lane ***diversions*** must be made upstream of all intersections for each direction of traffic.

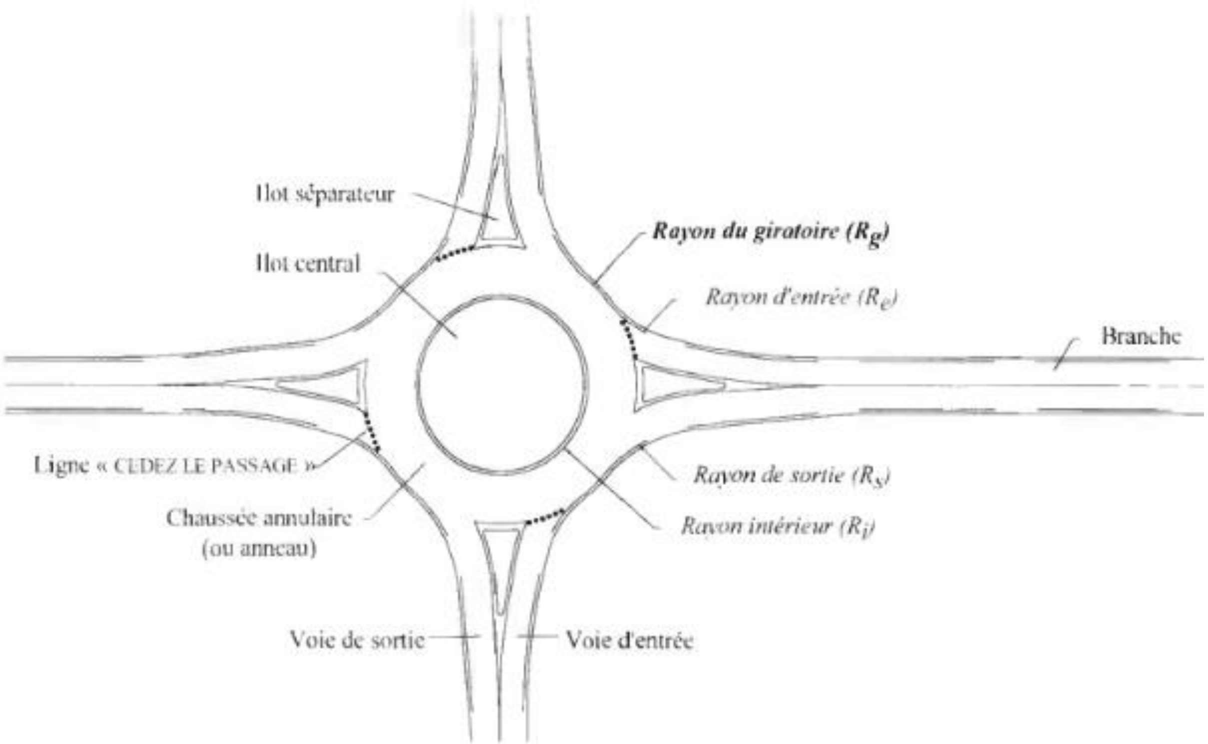
Fig. 9 — Principe d'aménagement des carrefours sur les routes à 3 voies en section courante.



Flat roundabout intersections 1/6

The roundabout is the flat intersection which offers the best level of safety if it is well designed and correctly sized.

The main elements and parameters of a roundabout are shown in the figure below.

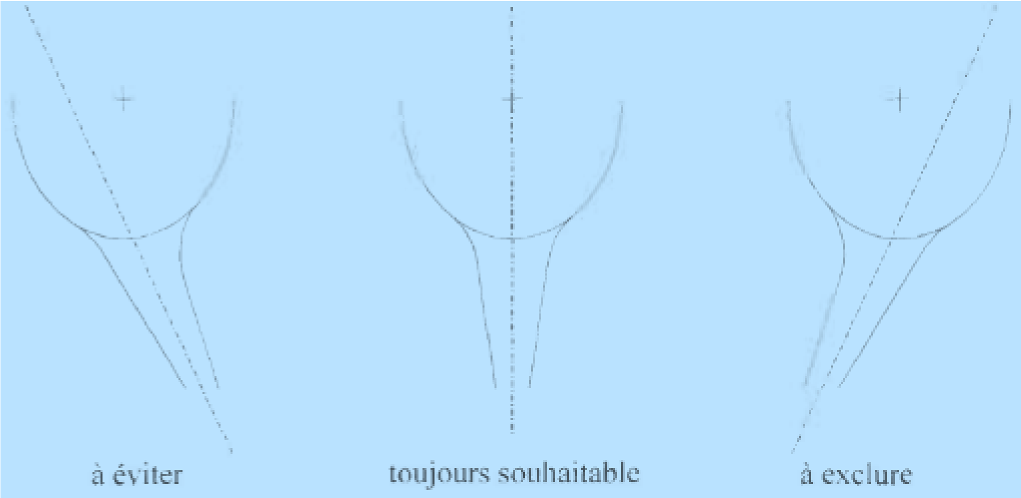


Flat roundabout intersections 2/6

General geometric configuration

The roundabout can have 3 to 6 branches distributed regularly around the ring in order to improve readability.

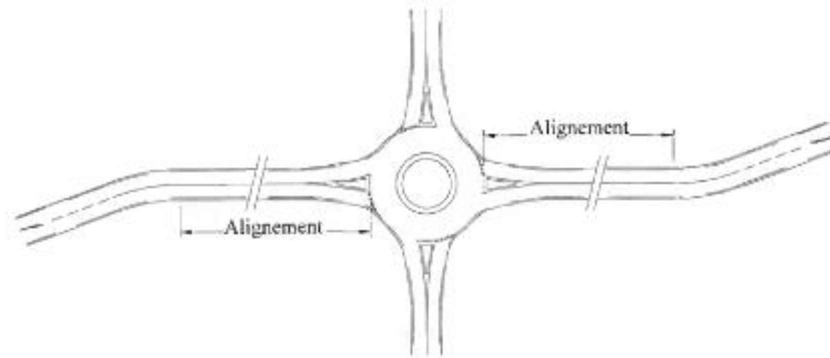
The position of the central island is ***optimal*** when all the ***axes of the branches*** pass through the ***center of the roundabout*** .



Flat roundabout intersections 3/6

General geometric configuration

Fig. 4 — Alignement radial des branches.



The roundabout must have a ***radial alignment*** over a length of approximately 150 to 250 m for a two-way road and 250 to 350 m in the case of a 2 x 2 way input.

For a 3-branched intersection the intersection must be transformed ***into a "Y "*** or " ***offset tee*** ".

Fig. 7 — Configuration des branches d'un giratoire « en té décalé ».

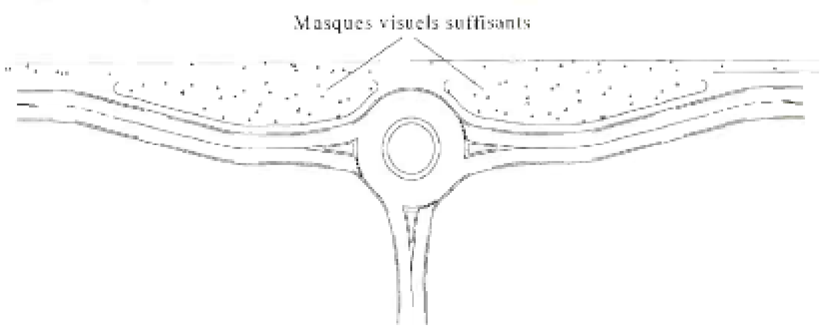
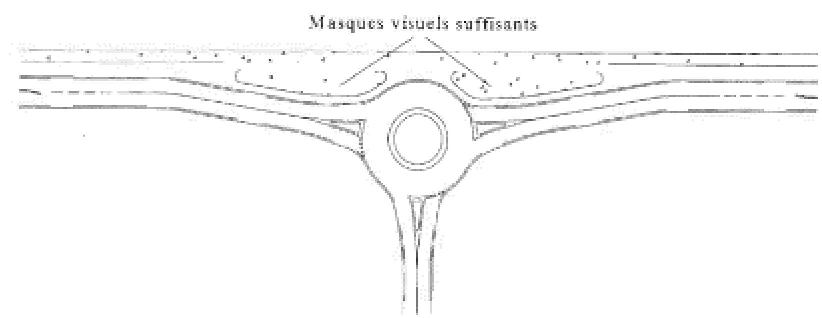


Fig. 6 — Configuration des branches d'un giratoire « en Y ».



Flat roundabout intersections 4/6

General geometric configuration

The general dimensions of the roundabout depend mainly on the number of lanes of the road, nature of traffic and the number of branches:

Two-way route:

The outer ring radius (R_g) must be between 15 and 25 m. The upper limit can be increased to 20 m in the case of roads with heavy heavy goods vehicle traffic and to 25 m in the case of a roundabout with a number of branches greater than 4. it is not recommended to choose an R_g <12m.

Dual carriageway:

A radius (R_g) of 25 m is generally recommended. In all cases, the width of the annular roadway cannot be less than 6 m.

Gradients:

Road with gradient ***less than 3%*** → ***no problem*** installing the roundabout.

Between 3% and 6% → reduction in the stability of heavy goods vehicles (insecurity).

Greater than 6% → significant problems (roundabout to be excluded and replaced by another type of intersection).

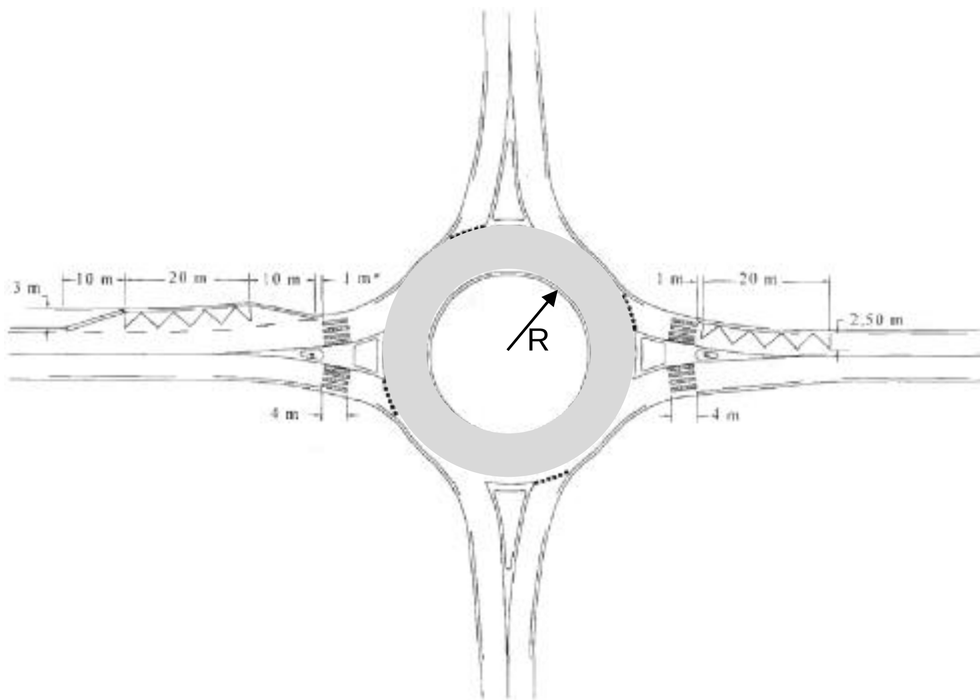
Flat roundabout intersections 5/6

General geometric configuration

The central island must be circular, it must have an internal radius between 6 and 10 m.

The width of ***the roundabout ring must be between 6 and 9 m*** wide . The annular roadway must have a uniform ***slope of* 1.5 to 2%** directed towards ***the outside*** of the intersection to improve the perception of the annular roadway, and facilitate the management of surface water flow.

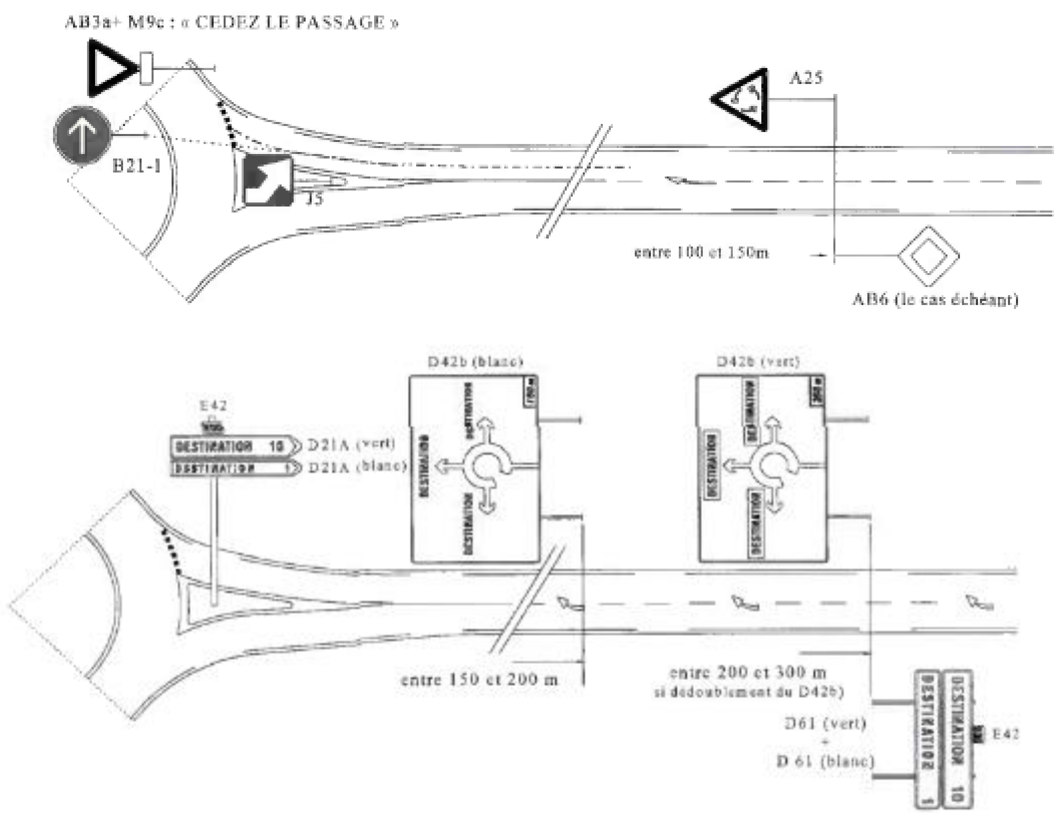
The roundabout may include adjustments for ***pedestrians*** and ***public transport*** .



Roundabouts 6/6

Road signs in roundabouts

- ✓Priority signaling
- ✓Prescription signage
- ✓markup
- ✓Direction signage
- ✓Horizontal signage (road marking)

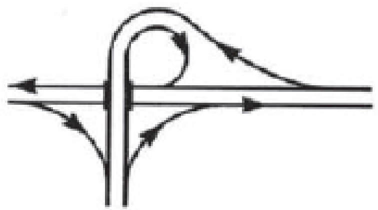


Uneven intersections 1/1

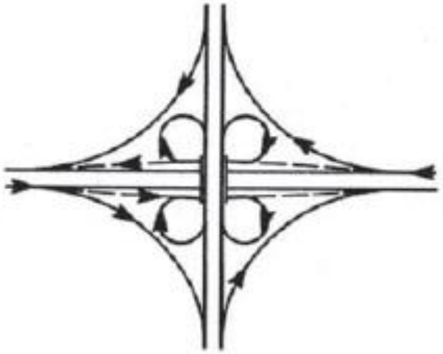
Grade-separated intersections, or ***interchanges*** , are more ***expensive*** than level intersections, but they offer much better safety conditions. They are generally used on highways. They can be classified into two main categories:

- *Crossroads without shearing:*

trumpet or full clover



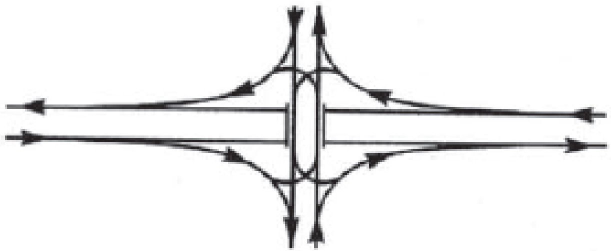
ⓐ trompette (à boucle d'entrée)



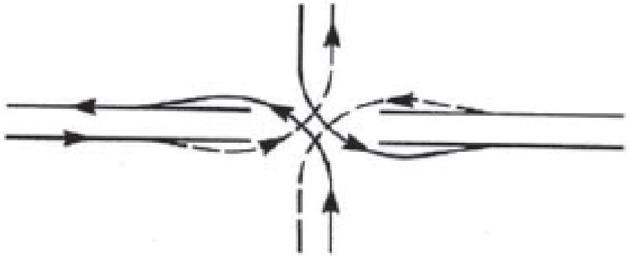
ⓑ trèfle complet

- *Crossroads with diamond-type shear:*

For secondary roads with low traffic.



ⓒ losange traditionnel



ⓓ losange indonésien (avec virages à gauche dos à dos)

5. Roadways

- General
- Shape layer
- Seat layers
- Surface layers

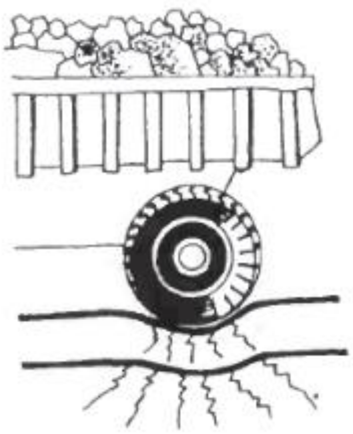
General

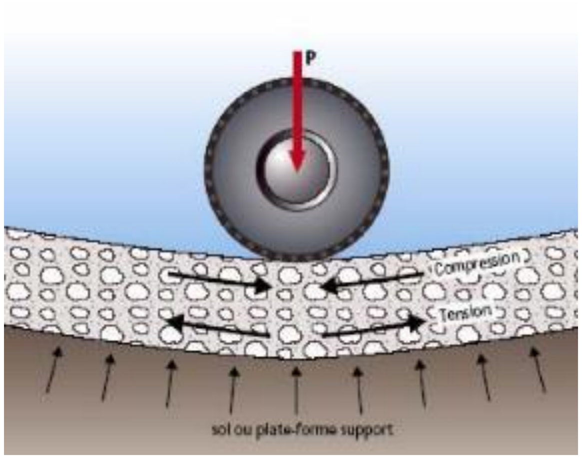
- Introduction
- Constituent elements of a roadway
- Different types of roadways

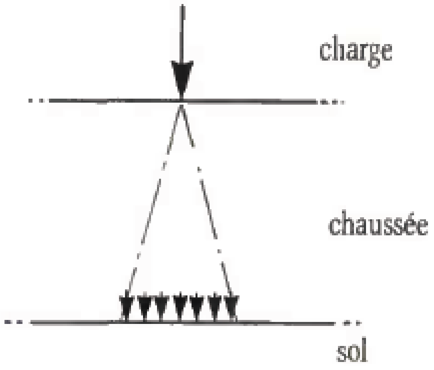
Introduction 1/3

The road must resist attacks from external agents and operating loads:

- Actions of the axles of heavy vehicles,
- Climatic effects: thermal gradients, rain, snow, ice, etc.







Introduction 2/3

To ensure that the roadway has good mechanical characteristics throughout its lifespan, it is necessary:

- Have a good knowledge of heavy goods vehicle traffic during the expected lifespan of the roadway,
- Have a good knowledge of the supporting soil,
- Make a good choice of constituent materials and good implementation.

Introduction 3/3

Some disorders caused by the action of the axles and climatic effects:

Figure 1 – Faïençage

Figure 2 – Fissuration transversale

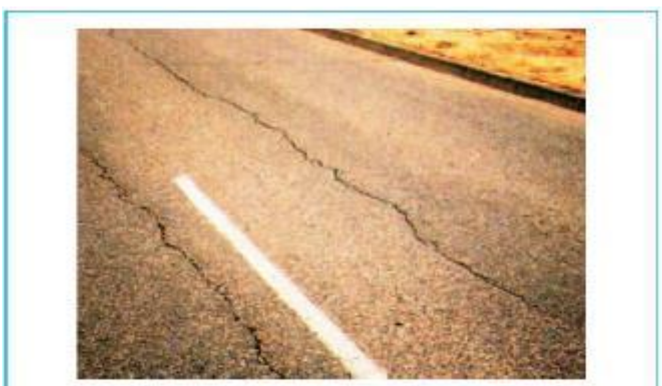


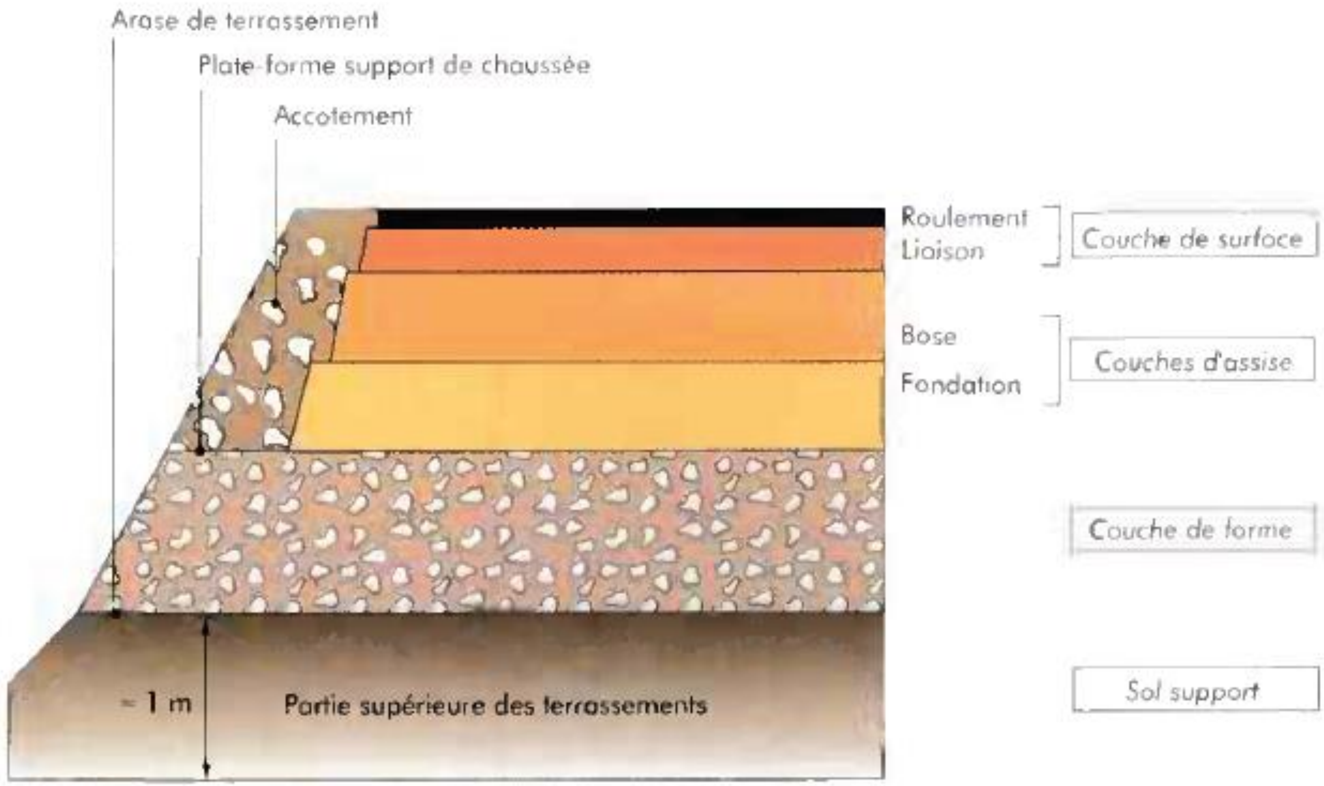
Figure 3 – Fissuration longitudinale

Figure 4 – Orniérage

Constituent elements of a roadway 1/1

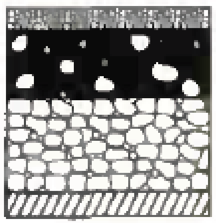
Definition

A roadway is the set of layers of materials superimposed and implemented in such a way as to allow the absorption of external loads.



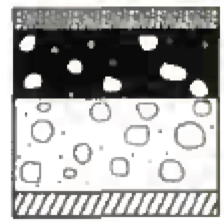
Different types of roadways 1/2

a) Flexible (e_T = 30 to 60 cm)



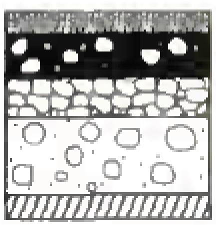
1. Bituminous concrete or ES
2. Gravel bitumen
3. Untreated Matx
4. Support platform

b) Mixed (e_T = 30 to 60 cm)



1. Asphalt concrete
2. Gravel bitumen
3. Matx treated with hydrau
4. Support platform

c) Reverse (e_T = 60 to 80 cm)

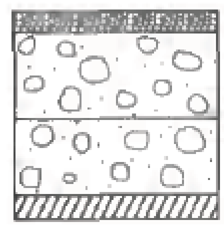


1. Asphalt concrete
2. Gravel bitumen
3. Unprocessed Matx
4. Matx treated with hydrau binders

.

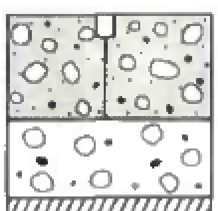
5. Support platform

d) Semi-rigid (e_T = 20 to 50 cm)

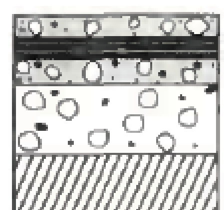


1. Asphalt concrete
2. Matx treated with hydrau
3. Matx untreated or treated with hydraulic binders
4. Support platform

e) Rigid (in cement concrete) (e_T = 20 to 40 cm)



1. Cement concrete slab
2. Lean concrete
3. Support platform



1. Continuous reinforced concrete slab
2. Lean concrete

Different types of roadways 2/2

Photos of a continuous reinforced concrete pavement

Shape layer

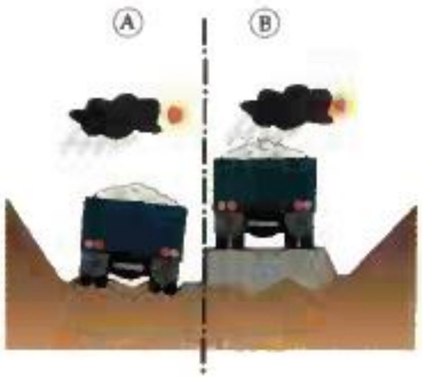
- Goals
- Nature of the form layer

Form layer 1/2

Goals

Meet certain objectives depending on the nature of the supporting soil:

- Leveling a rocky ground before laying the foundation layer
- Ensure sufficient bearing capacity in the short term for weak supporting soil (saturated clay, etc.) to allow construction machinery to circulate freely



Form layer 2/2

Nature of materials

Untreated grainy material

- Grainy material treated with hydraulic binders ***(cement, lime, slag, fly ash),***
- Soil ***treated in place*** with hydraulic binders

Dynaplate test (13 T axle): load-bearing capacity of the supporting ground

Seat layers

- Untreated seats
- Seats treated with hydrocarbon binders
- Seats treated with hydraulic binders

Seat layers 1/3

Definition *(base coat and foundation coat)*

Recovery of vertical forces and distribution of the resulting normal stresses on the underlying layers. We distinguish ***3 families*** :

A) Untreated bases:

Reserved for low and medium traffic roads (Wilaya roads and municipal roads). The materials used:

- **Natural:** tuffs, everything from the wadi, sand.

- **Crushed:** gravel crushed from massive rocks.

Seating layers 2/3

B) Seats treated with hydrocarbon binders:

Made with materials obtained by mixing crushed gravel with either **pure bitumen** (**gravel-bitumen** , sand-bitumen) or an **emulsion** (gravel-emulsion).

Noticed :

- Gravel-bitumen: roads with **heavy** and **very heavy** traffic
- Gravel-emulsion: **medium** and **low** traffic roads

Seating layers 3/3

C) The bases treated with hydraulic binders:

Made with materials obtained by mixing crushed gravel with a hydraulic binder (cement, slag, fly ash). We generally find them: **gravel-cement** , sand-cement, **gravel-slag** , **sand-slag** , gravel-fly ash.

This type of seat is reserved for roads with **heavy** and **very heavy** traffic .

Surface layers

- Functions and objectives
- Wearing layer
- Surface coatings
- Bituminous concretes

Surface layers 1/6

Definition

It is in direct contact with the tires, it is composed of a **tread layer** and a **connecting layer** (ensuring the transition with the more rigid lower layers, thickness of 5 to 7 cm).

Functions and purposes of surface layers:

- Safety and comfort of users: uniformity, adhesion, drainability , photometry (visibility), acoustics (limited noise).

- Protection of the foundation layers (foundation + base) against water infiltration and frost and by absorbing tangential stresses.

Surface layers 2/6

Wearing layer

Made from materials treated with **hydrocarbon binders** . Two techniques are most used in Algeria:

- Surface Coatings (ES)

- Bituminous concretes (BB)

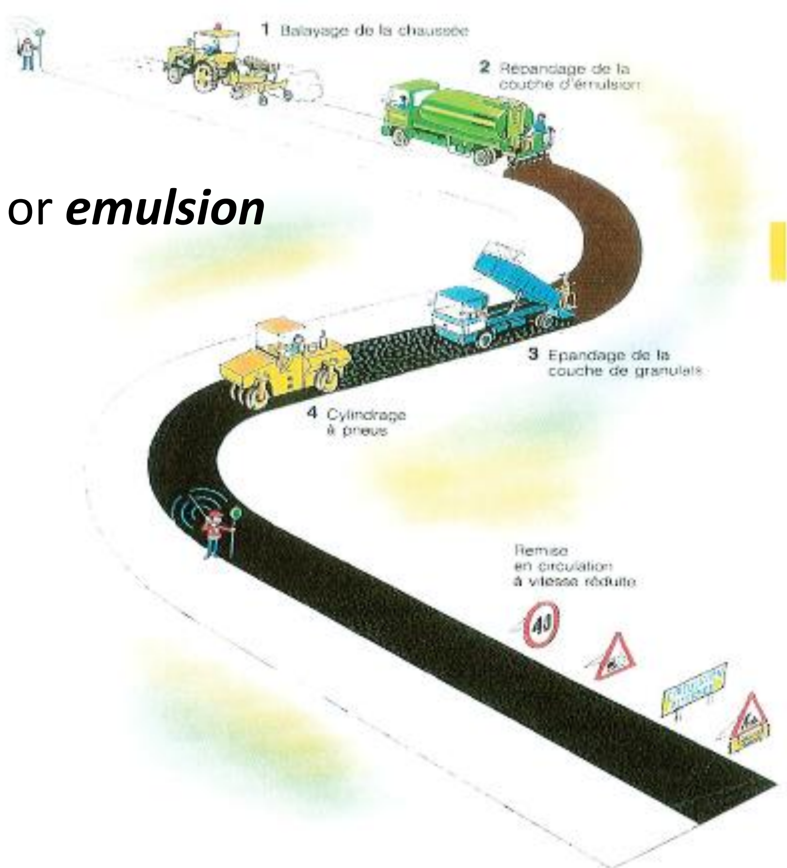
Surface layers 3/6

Wearing layer

A) Surface Coatings (ES)

Use for medium and light traffic roads

Mixture of aggregates with ***fluidized bitumen*** or ***emulsion***



<u>Noticed :</u>

Cutback bitumen = pure bitumen + kerosene

Emulsion = pure bitumen + emulsifier + water

Surface layers 4/6

Wearing layer

B) Bituminous Concrete (BB)

Materials ***hot coated*** with a bituminous binder.

- Thin bituminous concretes (BBM):

Grain size 0/10 or 0/14 + pure bitumen, thickness = 4 cm.

- Very thin bituminous concretes (BBTM):

Discontinuous grain size 0/10 with 25% sand 0/2, 70% 6/10 gravel and 6% bitumen modified by addition of polymer, rubber powder or fibers synthetic, thickness 2 to 4 cm, generally 2.5 cm.

- Ultra thin bituminous concretes (BBUM): *thickness = 1 cm*

- Draining bituminous concretes (draining BB): *thickness = 4 to 5 cm*

Surface layers 5/6

Choice of wearing course

Comparison criteria	ESU surface coatings	BBUM	BBTM	BBM	BB draining	Cement concrete
Initial adhesion	++	+	+	+	+	+
Adherence after 5 years	0 to +	+	+	0	+	0 to +
Drainability	+	0 to -	0	++	0	0 to +
United	-	-	0	+	+	+
Acoustic	- has --	0 to +	+	0 to +	++	- to 0
++ Very good + good 0 average - mediocre -- bad						

Surface layers 6/6

Implementation of the wearing course

Implementation temperature for bituminous concretes is between 130 to 150°C

END