

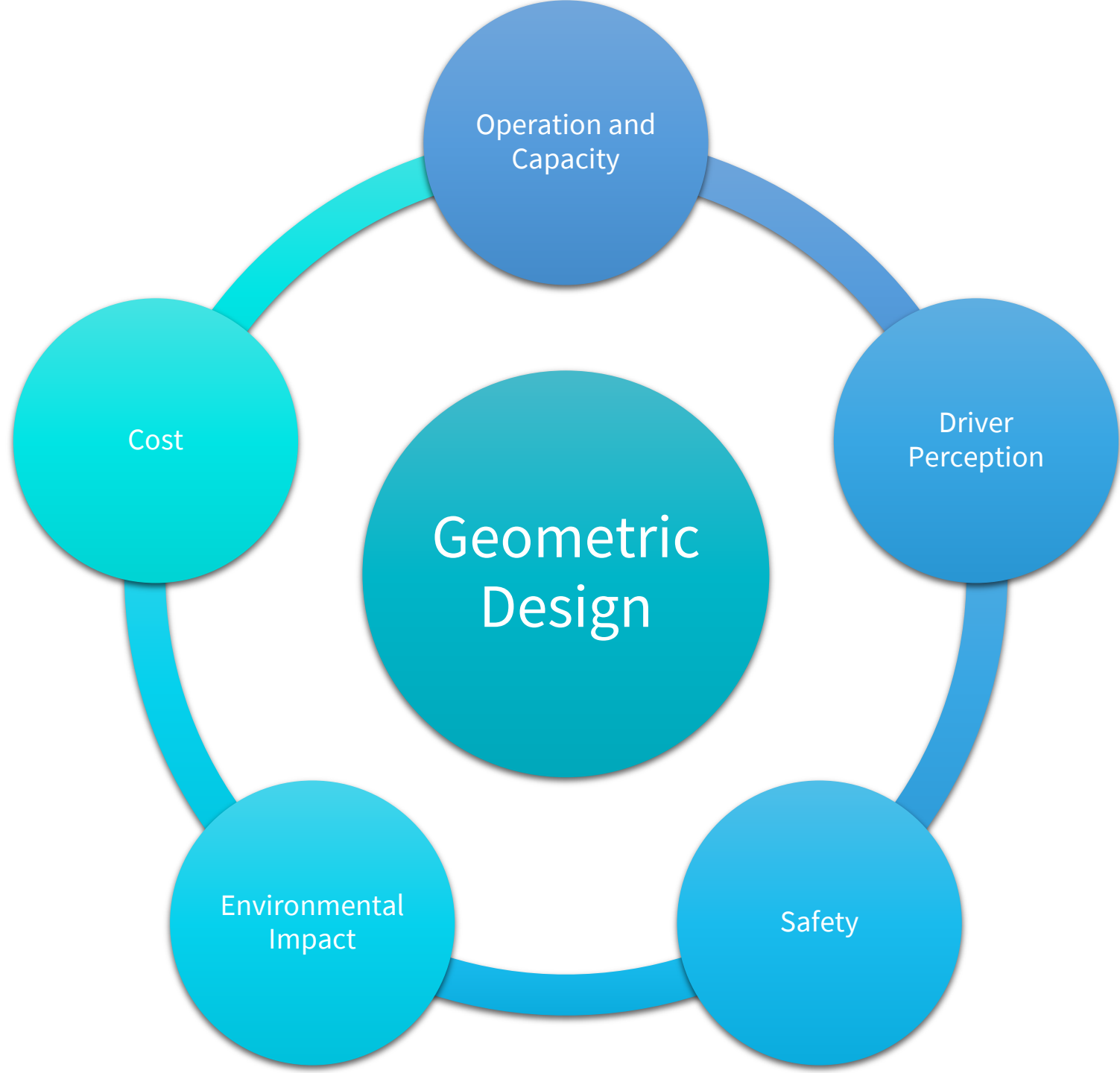




Geometric Design of Highways

Starting point of geometric design is creation of a horizontal and vertical alignment, from which other features are added.





Capacity

How much carriageway is required for a new road?



Capacity

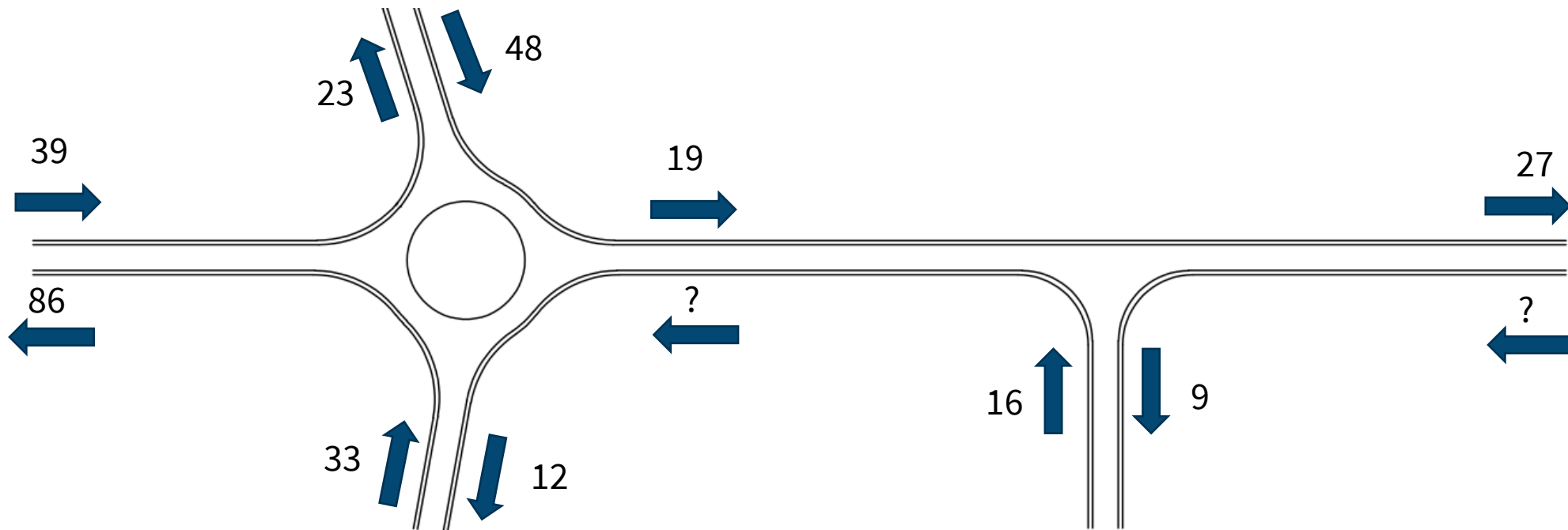
Average Annual Daily Traffic



Capacity

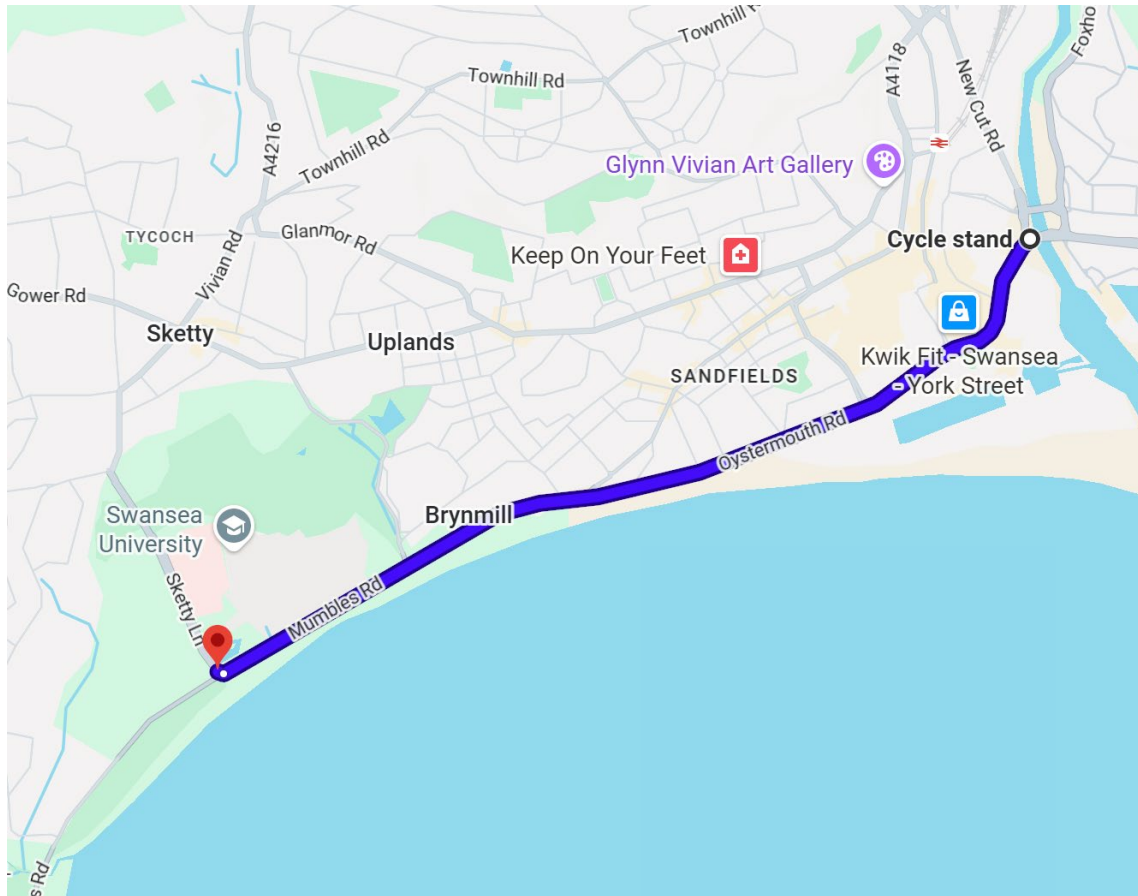
The diagram below shows the traffic flow for a one-hour period

Calculate the missing values



Capacity

Step 1. Estimating the Design Traffic Flow



Capacity

Step 1. Estimating the Design Traffic Flow

Year	Road	Start	End	Cycles	Motorbikes	Cars	Bus / Coach	LGVs	HGVs_2 Rigid	HGVs_3 Rigid	HGVs_4 Rigid	HGVs_3/4 Articulated	HGVs_5 Articulated	HGVs_6 Articulated	All HGVs	All Motor Vehicles
2000	A4067	A4216	A483	87	144	30749	52	2043	302	66	29	15	11	3	426	33414
2001	A4067	A4216	A483	75	147	30509	264	1698	491	38	27	16	10	6	588	33206
2002	A4067	A4216	A483	51	159	31557	156	2088	268	40	66	13	11	3	401	34361
2003	A4067	A4216	A483	54	119	27396	162	2110	334	67	48	16	16	7	488	30275
2004	A4067	A4216	A483	92	163	31619	265	2109	316	52	29	8	13	4	422	34578
2005	A4067	A4216	A483	166	188	29905	134	2442	273	90	51	26	15	12	467	33136
2006	A4067	A4216	A483	61	105	31553	156	2549	313	64	48	16	22	6	469	34832
2007	A4067	A4216	A483	191	179	31673	233	2671	299	65	119	5	7	11	506	35262
2008	A4067	A4216	A483	761	198	26922	169	2349	309	56	18	6	8	6	403	30041
2009	A4067	A4216	A483	761	187	26491	165	2544	297	58	18	6	7	6	392	29779
2010	A4067	A4216	A483	761	172	25935	174	2557	295	54	15	6	6	6	382	29220
2011	A4067	A4216	A483	840	182	25806	174	2636	293	58	17	4	6	6	384	29182
2012	A4067	A4216	A483	794	164	25697	187	2531	259	55	17	3	6	6	346	28925
2013	A4067	A4216	A483	374	177	27193	188	2425	199	42	83	10	8	12	355	30338
2014	A4067	A4216	A483	363	188	26911	200	2762	210	48	93	11	8	14	385	30445
2015	A4067	A4216	A483	338	191	26417	198	2905	205	51	91	13	8	14	381	30092
2016	A4067	A4216	A483	811	185	28082	261	2667	200	46	90	11	4	10	362	31557
2017	A4067	A4216	A483	804	217	28916	290	2726	213	61	45	16	12	6	353	32502
2018	A4067	A4216	A483	888	214	28598	263	2777	215	61	44	16	13	6	354	32206
2019	A4067	A4216	A483	974	201	28956	266	2753	212	62	44	16	13	6	354	32530
2020	A4067	A4216	A483	1114	148	21995	168	2430	187	54	39	14	11	5	311	25051
2021	A4067	A4216	A483	543	175	25544	183	3415	203	68	24	15	6	10	326	29643
2022	A4067	A4216	A483	486	191	27283	196	3703	210	71	25	15	7	10	338	31711
2023	A4067	A4216	A483	478	188	27796	198	3765	207	69	25	16	6	9	333	32281
2024	A4067	A4216	A483	483	194	28218	199	3833	210	70	24	15	6	9	335	32779
2025	A4067	A4216	A483	484	198	28251	195	3911	208	70	25	15	6	9	333	32889

Capacity

Step 1. Estimating the Design Traffic Flow

Commercial vehicle (cv)	cv class*	cv category
	Buses and coaches	PSV
	2-axle rigid	OGV1
	3-axle rigid	
	3-axle articulated	OGV2
	4-axle rigid	
	4-axle articulated	
	5-axle articulated	
	6 (or more) axle articulated	

*classed by axles in contact with the road

PSV = Public service vehicles

OGV = Other goods vehicles

Capacity

Step 1. Estimating the Design Traffic Flow

Current traffic is rarely used directly. Designers usually forecast traffic to the end of the design life.

$$\textit{Future AADT} = \textit{Present AADT} \times (1 + r)^n$$

Where:

r = Annual Growth Rate

n = Number of Years

Capacity

Step 1. Estimating the Design Traffic Flow

Current traffic is rarely used directly. Designers usually forecast traffic to the end of the design life.

$$\text{Future AADT} = \text{Present AADT} \times (1 + r)^n$$

Where:

r = Annual Growth Rate

n = Number of Years

Calculate the Future AADT for Mumbles Road based on the Present AADT of 32889, an annual growth rate of 2% and a design period of 20 years.

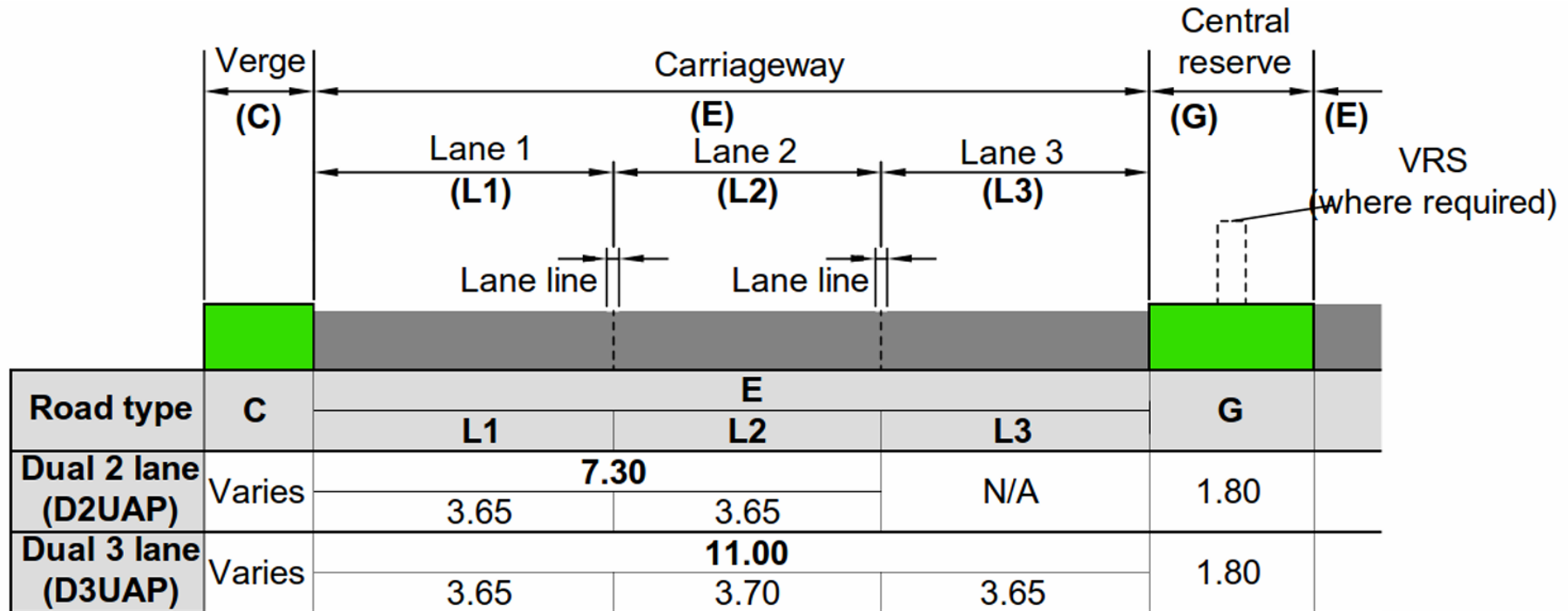
Capacity

Step 2. Assess Required Capacity

Road Standard	AADT
Single 2-Lane	< 13,000
Wide Single 2-Lane	6,000 – 21,000
Dual 2-Lane All Purpose	11,000 – 39,000
Dual 3-Lane All Purpose	23,000 – 54,000
Dual 2-Lane Motorway	< 41,000
Dual 3-Lane Motorway	25,000 – 67,000

Capacity

Step 3. Select Cross-Section



Dual carriageway

Capacity

Step 3. Select Cross-Section



Design Speed

Design Speed is one of the most important concepts in Highway Design because it governs many of the geometric features of the road.

Why design speed matters

Higher speeds leave less time for drivers to respond — so the road must provide more distance, smoother curvature and greater visibility.



As design speed increases, geometric requirements grow:

- larger curve radii
- longer stopping sight distances
- flatter gradients
- larger junction layouts

Design speed	Curve radius	Stopping sight distance
50 km/h	Small	70 m
85 km/h	Medium	120 m
120 km/h	Large	295 m

Higher design speeds generally require more land and higher construction cost.

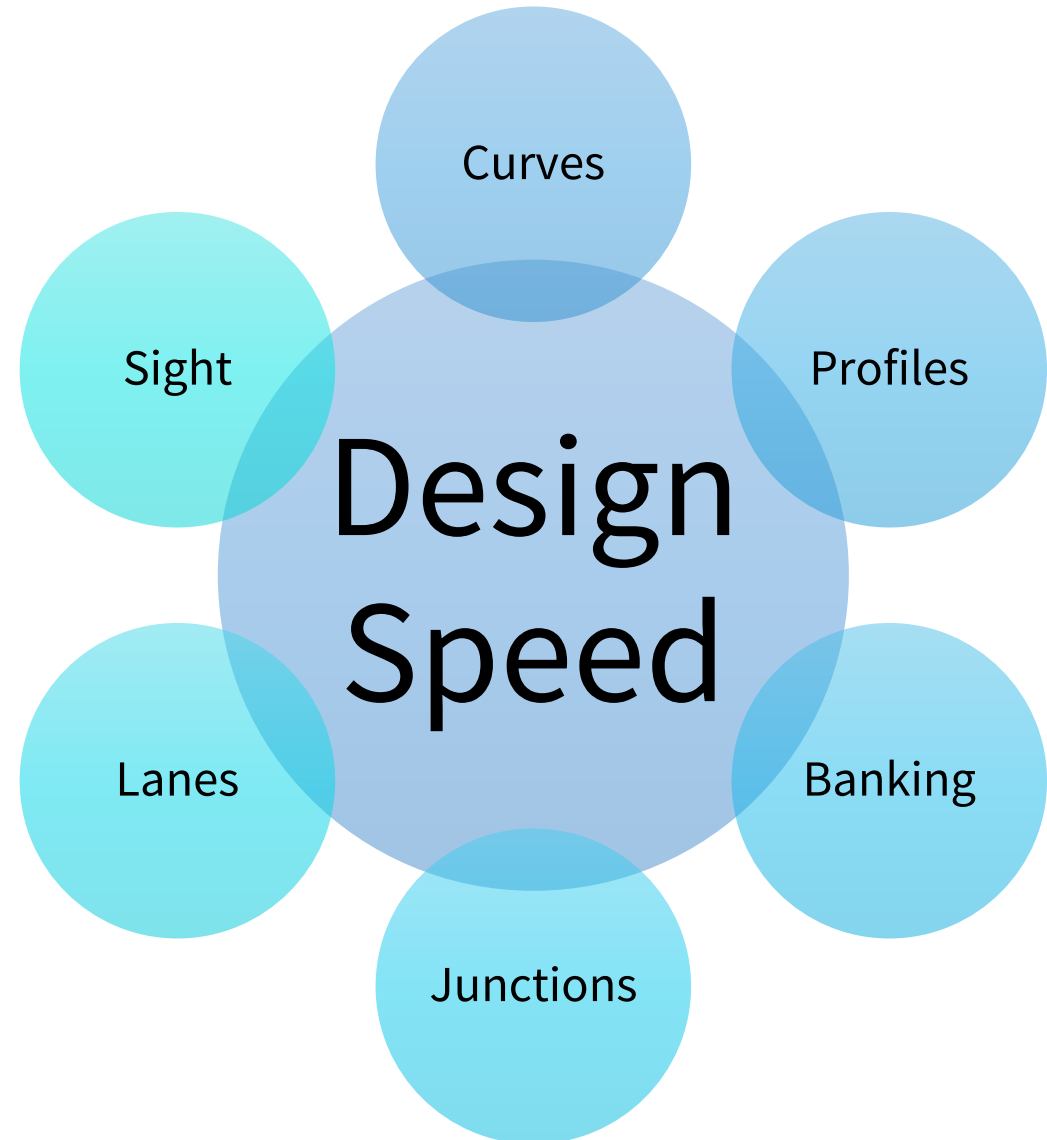
What design speed controls

Design speed is the **selected speed** used to establish the minimum geometric standards for safe, comfortable road alignment.

In simple terms, it defines how forgiving a road feels to drivers travelling under favourable conditions.

KEY DEFINITION

The speed used by highway engineers to derive road geometry, visibility and alignment standards.



Design speed vs speed limit

These terms are often confused: one is an engineering input; the other is a legal operating control.

Design speed	Speed limit
Engineering parameter used for road design	Legal maximum speed
Determines road geometry	Influences and regulates driver behaviour
Selected during planning or assessment	Set by highway authorities
May be higher than the posted limit	Enforced by law

Example: road designed for **120 km/h** and posted at **70 mph (113 km/h)** — the geometry provides an additional safety margin.

Factors that set design speed

Engineers choose a design speed by balancing road role, context, users and environmental constraints.

ROAD FUNCTION

- Motorway
- Primary route
- Local road
- Residential street

TERRAIN

- Flat terrain allows higher speeds
- Hilly or mountainous terrain often lowers speed

TRAFFIC COMPOSITION

- Percentage of HGVs
- Traffic volume
- Cyclists and pedestrians

ENVIRONMENTAL CONSTRAINTS

- Urban development
- Existing infrastructure
- Protected landscapes

Design speed in UK highway design

In DMRB-based design, geometry is selected using Design Speed (DS) and existing roads are checked against measured 85th percentile speed.

Road type	Typical design speed
Rural motorway	120 km/h
Rural dual carriageway	120 km/h
Rural single carriageway	100 km/h
Urban distributor road	60–85 km/h
Residential street	20–40 km/h

WORKED EXAMPLE

A rural dual carriageway designed for 120 km/h uses that speed to determine:

- stopping sight distance
- minimum horizontal curve radius
- superelevation rate
- crest and sag curve lengths
- junction visibility requirements

If DS is reduced to 85 km/h, these requirements can generally reduce — creating a cheaper, more compact design.

Key point: design speed is one of the most important inputs because alignment and visibility standards are derived from it.

Sight Distance

Sight Distance is the length of road ahead that is visible to a driver.

It is a fundamental safety requirement because drivers must be able to see hazards in sufficient time to react and stop safely

Sight Distance

When designing a road, engineers must ensure that:

01

Drivers can see around bends

02

Drivers can see over hills and crests

03

Roadside features do not obstruct visibility

04

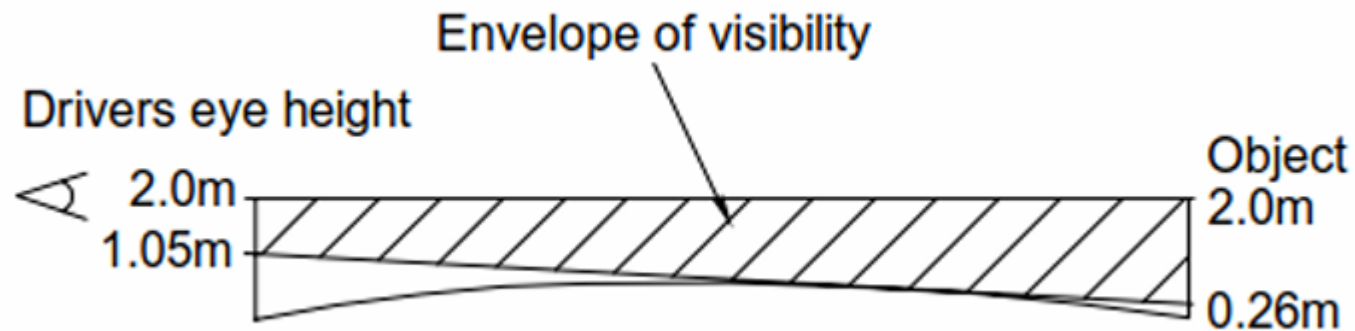
The available visibility is at least equal to the required stopping distance

Sight Distance



Conceptually:

Stopping Sight Distance = Reaction Distance + Braking Distance



Sight Distance

Design Speed (km/h)	Design Speed (mph)	SSD (m)
50	31	
60	37	
70	43	
85	53	
100	62	
120	75	

Sight Distance

Design Speed (km/h)	Design Speed (mph)	SSD (m)
50	31	70
60	37	90
70	43	120
85	53	160
100	62	215
120	75	295

Sight Distance

ON A BEND, VISIBILITY CAN BE RESTRICTED BY:

1 EARTHWORKS



2 VEGETATION



3 SAFETY BARRIERS



4 RETAINING WALLS



5 BUILDINGS



REDUCED VISIBILITY
INCREASES RISK.

**SLOW DOWN, STAY ALERT
AND BE PREPARED.**



ALL OF THE ABOVE CAN RESTRICT VISIBILITY ON A BEND.

Horizontal Curvature

Horizontal curvature (metres)

Minimum R* with adverse camber and without transitions 2880

2040 1440 1020 720 520 5

Minimum R* with superelevation of 2.5% 2040 1440 1020 720

510 360 7.07 Minimum R* with superelevation of 3.5% 1440 1020

720 510 360 255 10

Camber: drainage crossfall

A camber is the normal crossfall that helps rainwater drain away from the carriageway.

PURPOSE

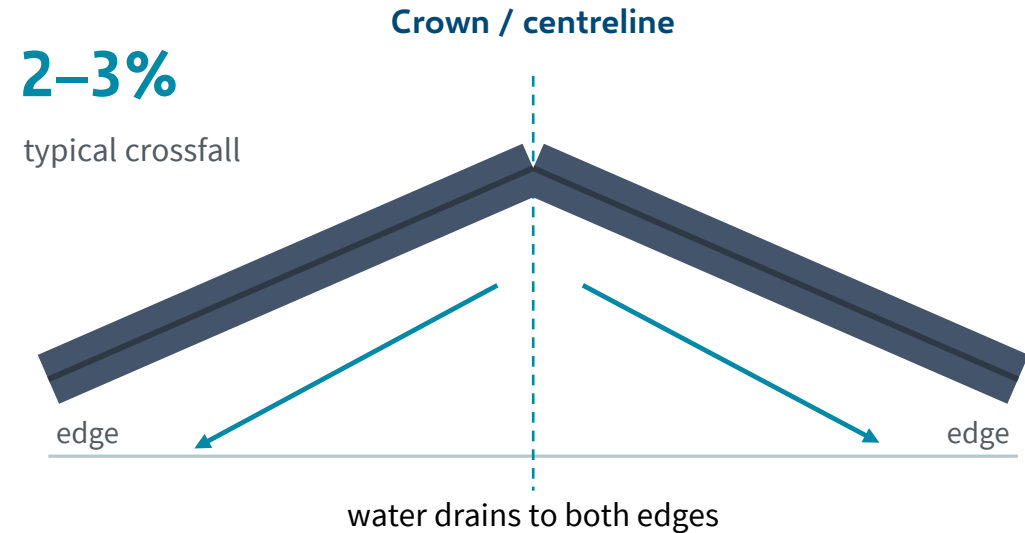
Remove surface water from the running lanes before it ponds or weakens the pavement.

USUALLY USED ON

Straight sections and general road cross-sections, with the crown on or near the centreline.

Why it matters

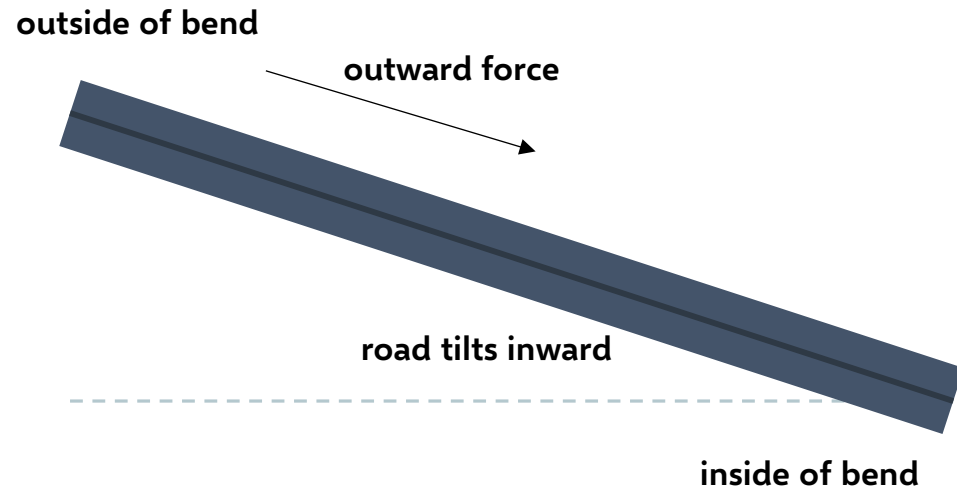
1. Reduces ponding and spray
2. Lowers aquaplaning and skidding risk
3. Slows pavement deterioration



Common paved-road value: about 2.5% (1 in 40)

Superelevation: tilting road on curves

Superelevation rotates the whole carriageway towards the inside of a bend for vehicle stability.



7–10%

possible maximum range, subject to standards and site conditions

PURPOSE

Counteract the outward effect of centrifugal force when vehicles travel around a horizontal curve.

HELPS TO

- 1 Reduce tendency to skid
- 2 Improve driver comfort
- 3 Reduce reliance on tyre friction
- 4 Improve safety at higher speeds

Superelevation: tilting road on curves

$$S = \frac{V^2}{2.828R}$$

Where:

V = Design Speed (km/h)

R = Radius (m)

S = Superelevation (%)

What does the superelevation of the road need to be on a 70kph road with a bend radius of 510m?

Gradients

	Desirable Maximum	Permitted Relaxations
Motorways	3%	4%
All-purpose dual carriageways	4%	8%
All-purpose single carriageways	6%	8%



Gradient

Vertical curves must be calculated at all changes in gradient

They shall be designed to ensure a safe stopping distance at the maximum design speed and a clear line of sight

DESIGN SPEED kph	120	100	85	70	60	50	V^2/R
STOPPING SIGHT DISTANCE m							
Desirable Minimum	295	215	160	120	90	70	
One Step below Desirable Minimum	215	160	120	90	70	50	
HORIZONTAL CURVATURE m.							
Minimum R* without elimination of Adverse Camber and Transitions	2880	2040	1440	1020	720	520	5
Minimum R* with Superelevation of 2.5%	2040	1440	1020	720	510	360	7.07
Minimum R* with Superelevation of 3.5%	1440	1020	720	510	360	255	10
Desirable Minimum R with Superelevation of 5%	1020	720	510	360	255	180	14.14
One Step below Desirable Minimum R with Superelevation of 7%	720	510	360	255	180	127	20
Two Steps below Desirable Minimum Radius with Superelevation of 7%	510	360	255	180	127	90	28.28
VERTICAL CURVATURE							
Desirable Minimum* Crest K Value	182	100	55	30	17	10	
One Step below Desirable Min Crest K Value	100	55	30	17	10	6.5	
Absolute Minimum Sag K Value	37	26	20	20	13	9	
OVERTAKING SIGHT DISTANCES							
Full Overtaking Sight Distance FOSD m.	*	580	490	410	345	290	
FOSD Overtaking Crest K Value	*	400	285	200	142	100	

Gradient

K values are used to calculate the minimum level of the curve at a change in gradient.

$$Length = k \times \text{change in gradient}$$

What is the desired length at a change in gradient from + 3% to -2% on a road with design speed 120kph?

DESIGN SPEED kph	120	100	85	70	60	50	V ² /R
STOPPING SIGHT DISTANCE m							
Desirable Minimum	295	215	160	120	90	70	
One Step below Desirable Minimum	215	160	120	90	70	50	
HORIZONTAL CURVATURE m.							
Minimum R* without elimination of Adverse Camber and Transitions	2880	2040	1440	1020	720	520	5
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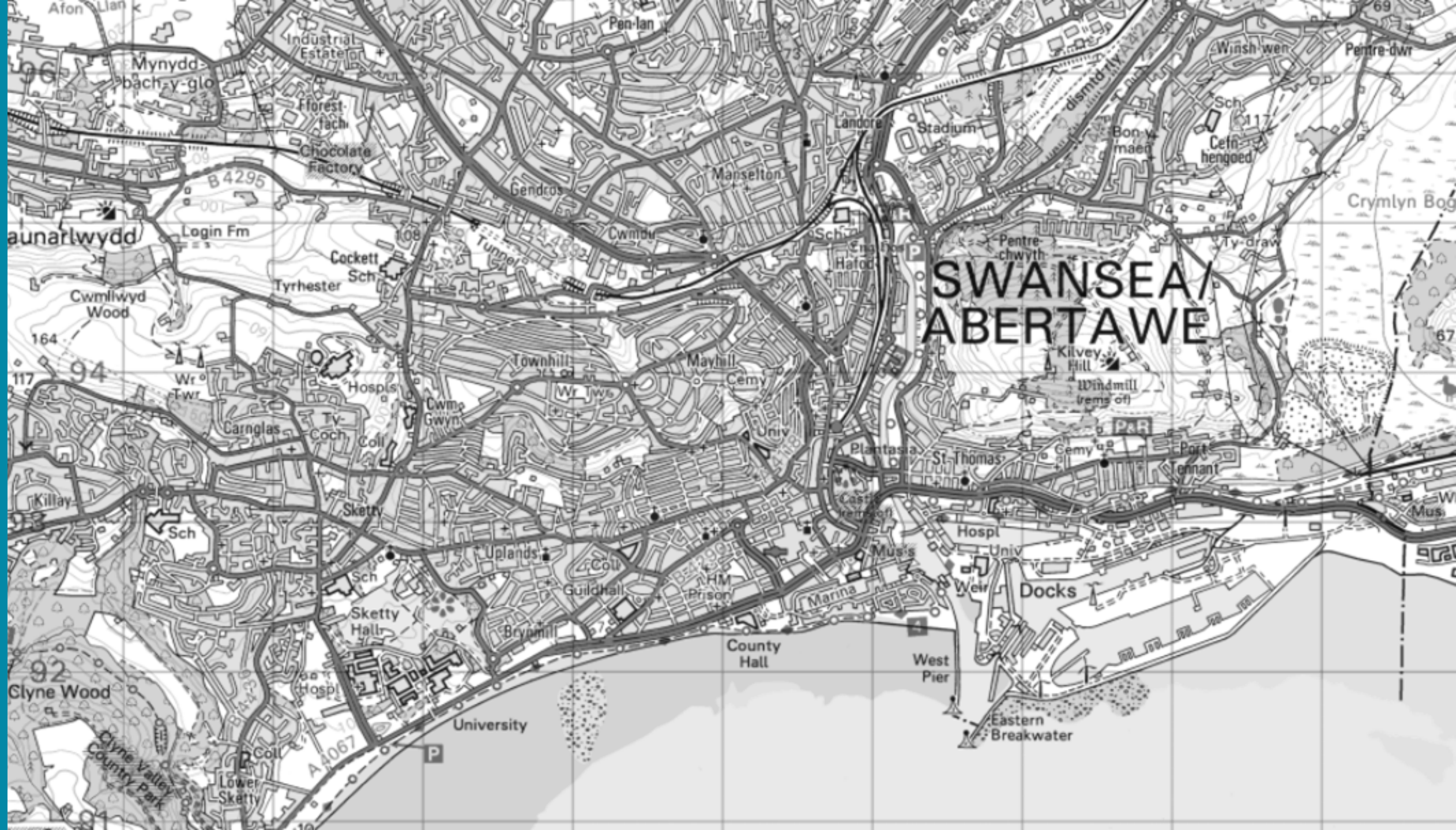
Route Alignment



Route Alignment

OS maps are often used for initial vertical alignment design before surveys are complete

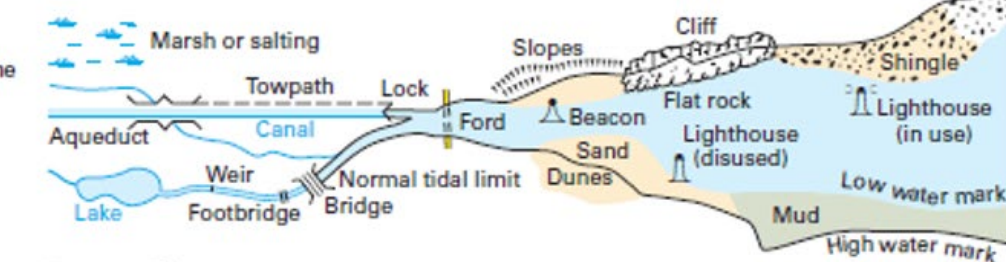




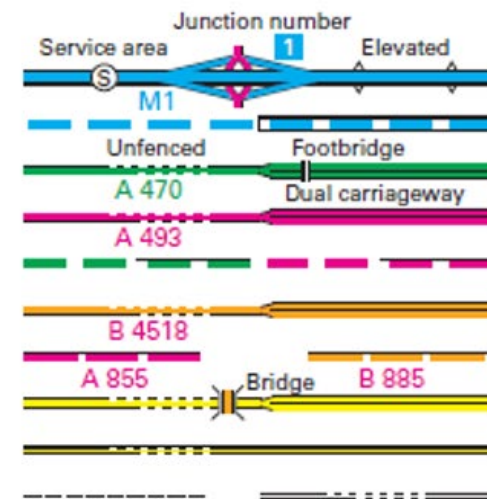
Landranger® (Present day) Only a selection of the more important symbols have been shown.

	Track multiple or single		Bridges / Footbridge		Electricity transmission line (pylons shown at standard spacing)
	Track under construction		Level crossing		Pipe line (arrow indicates direction of flow)
	Siding		Viaduct		Buildings
	Tunnel		Station, (a) principal		Public building (selected)
	Light rapid transit system, narrow gauge or tramway		Light rapid transit syst station		Bus or coach station

	} Place of worship	with tower
		with spire, minaret or dome
		without such additions
	Chimney or tower	
	Glass structure	
	Heliport	
	Triangulation pillar	
	Mast	
	Wind pump / wind generator	
	Windmill with or without sails	



	Orchard / Park or ornamental ground		Cutting / embankment
	Spoil heap, refuse tip or dump		Quarry
	Coniferous wood		Contours are at 10 metres vertical interval
	Non-coniferous wood		Heights are to the nearest metre above mean sea level
	Mixed wood		



	Motorway (dual carriageway)
	Motorway under construction
	Primary Route
	Main road
	Primary Route / Main road under cons
	Secondary road
	Narrow road with passing places
	Road generally more than 4m wide
	Road generally less than 4m wide
	Path / Other road, drive or track

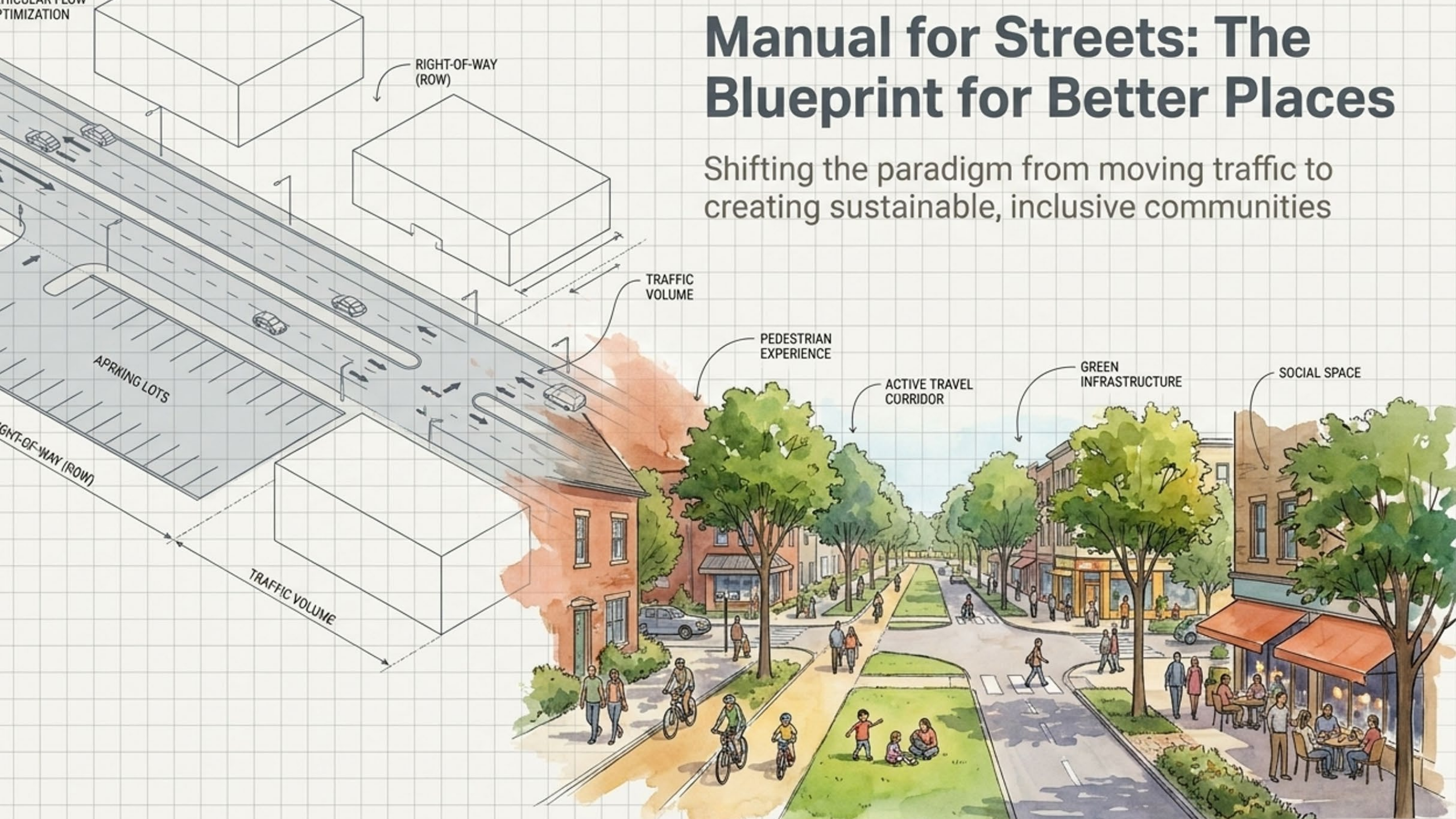
	} Place of worship	with tower
		with spire, minaret or dome
		without such additions
	Chimney or tower	
	Glass structure	
	Heliport	
	Triangulation pillar	
	Mast	
 	Wind pump / wind generator	
	Windmill with or without sails	

Permitted Relaxations

Band A	Band B
Normal or desirable design standard	Relaxation from the desirable standard
Used where no significant site constraints	Used only where physical, environmental or economic constraints make Band A impractical
Provides highest level of driver comfort, consistency and safety	Allows tighter curves and reduced geometric requirements while remaining within acceptable safety limits.
Curves are generally larger and require less steering effort from drivers	Requires engineering judgement and justification.

Manual for Streets: The Blueprint for Better Places

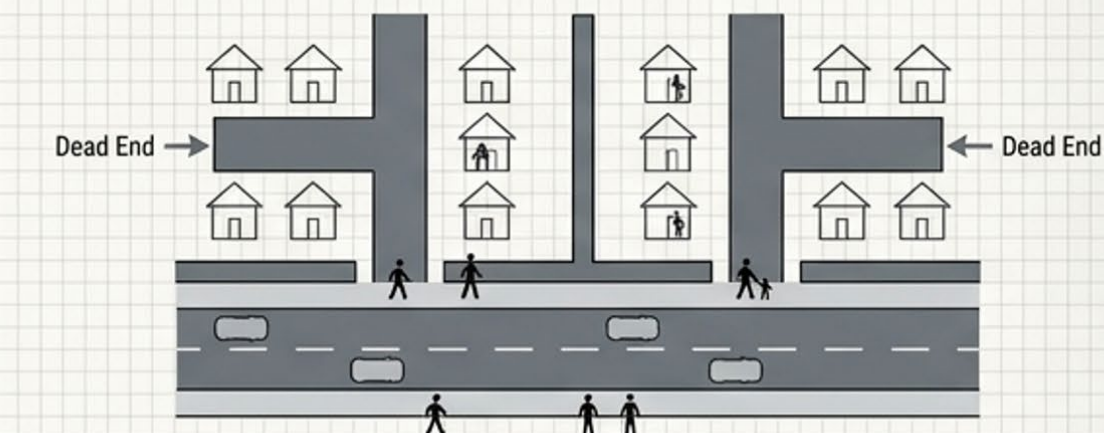
Shifting the paradigm from moving traffic to creating sustainable, inclusive communities



The Core Problem: Segregation vs. Integration

The Failure of Segregation

Cold Technical Colors: Engineering Slate, Asphalt Grey

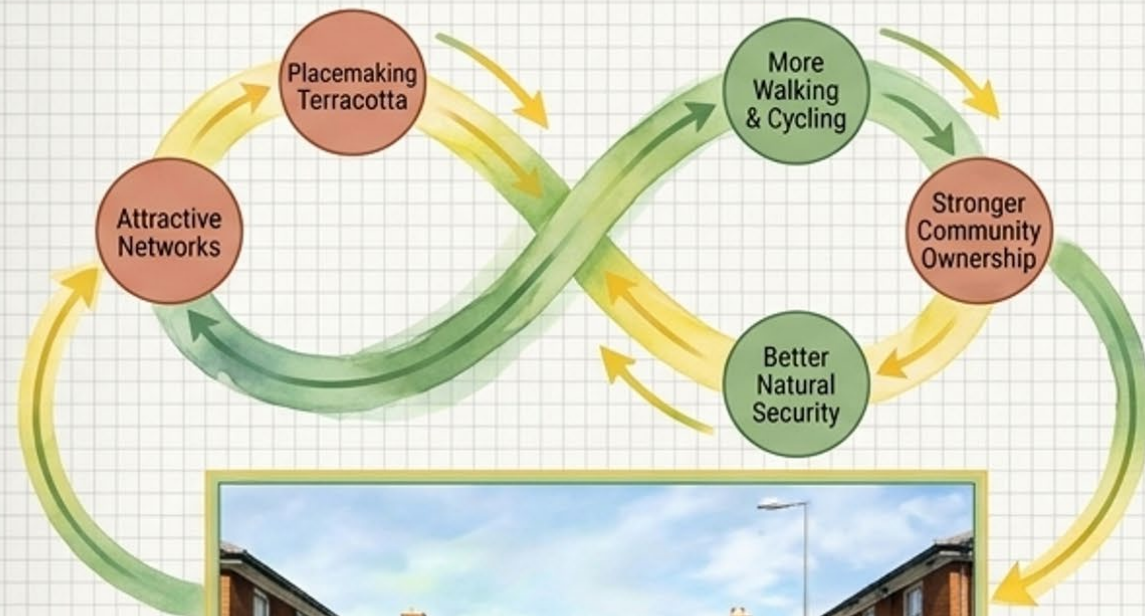


The post-war distributor/access road hierarchy assumed pedestrians and vehicles must be kept apart. Result: isolated communities, disjointed development, and reliance on cars for short trips.

SEGREGATION
ISOLATION

The Virtuous Circle

Warm Organic Colors: Placemaking Terracotta, Canopy Green, Active Yellow



Active Street



POSITIVE
FEEDBACK

Community
Connection

Integrated, multi-functional streets create a positive feedback loop: Attractive Networks → More Walking & Cycling → Better Natural Security → Stronger Community Ownership.

INTEGRATION
POSITIVE FEEDBACK



ROADS



STREETS

Definition

A highway whose main function is accommodating the movement of motor traffic.

A highway that has important public realm functions beyond the movement of traffic.

Primary Metric

Vehicular capacity and speed.

Sense of place and local distinctiveness.

Spatial Relationship

Buildings are set back; physically isolates communities.

Lined with buildings and public spaces; integrates communities.

Design Approach

Standardized, predictable, and movement-first.

Context-specific, multi-functional, and place-first.

Place versus Movement

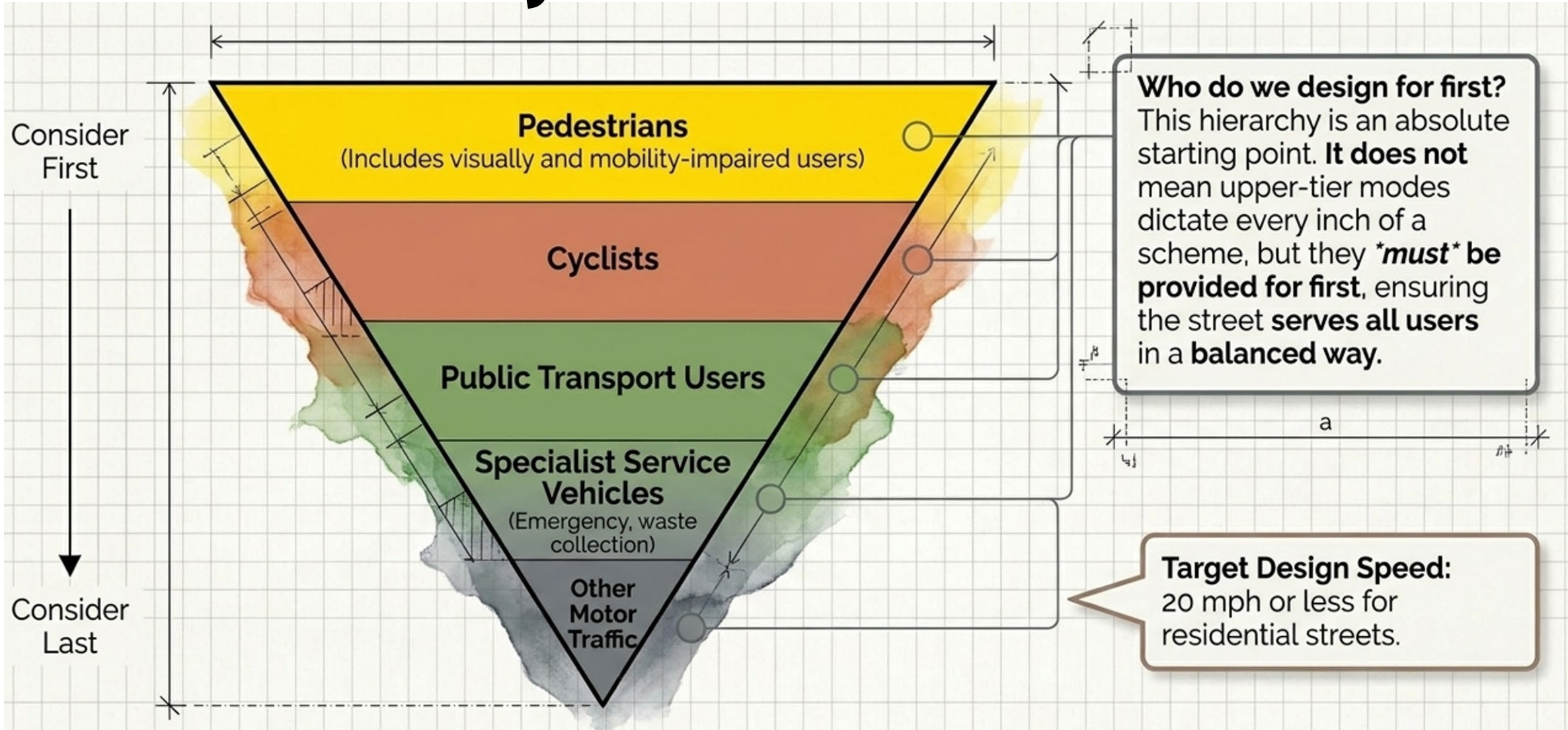




Anatomy of a Street

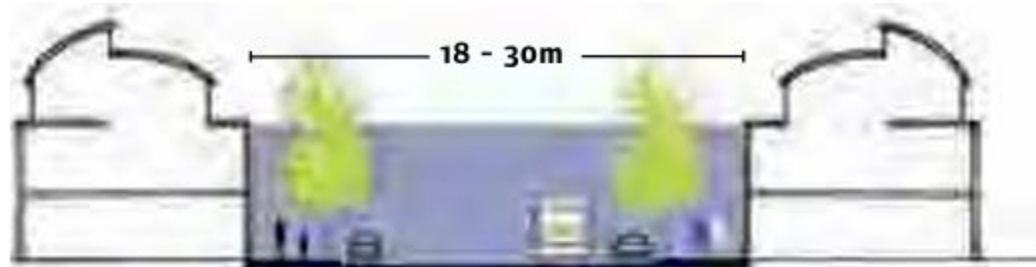


User Hierarchy

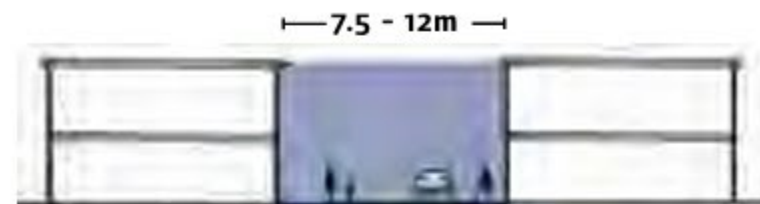


Collaborative Approach

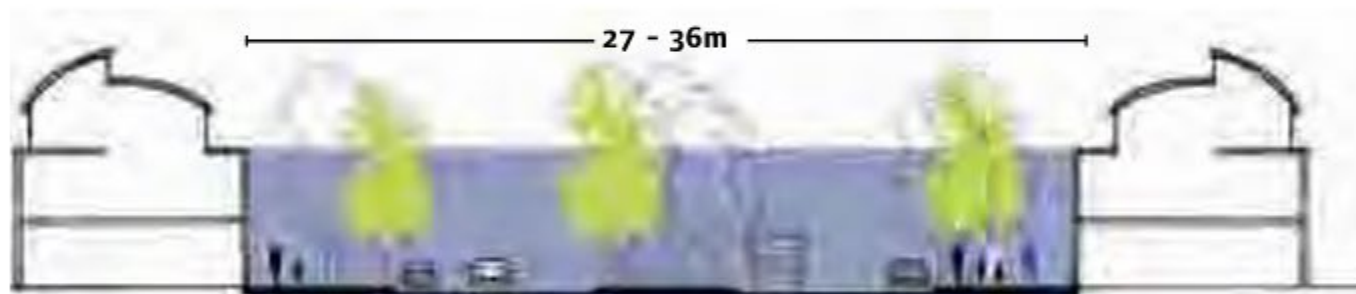




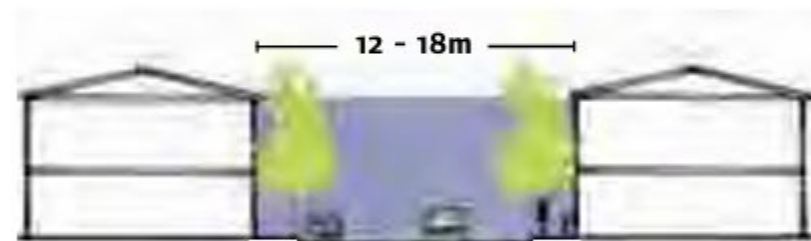
High Street



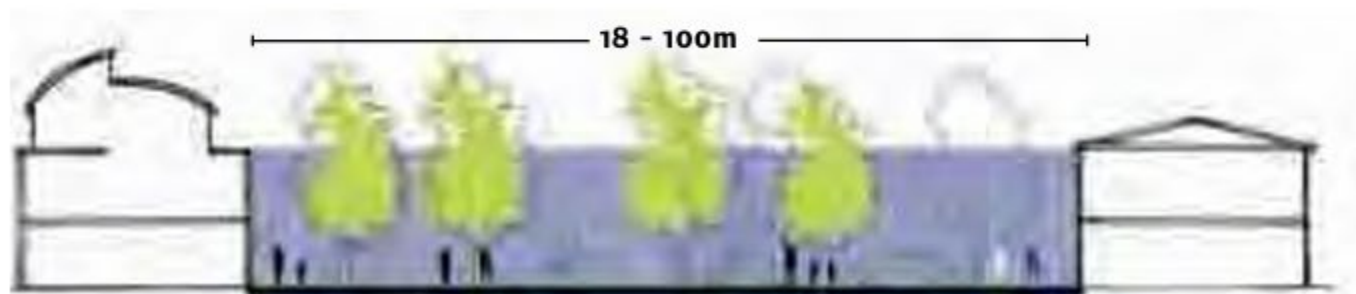
Mews



Boulevard



Residential Street

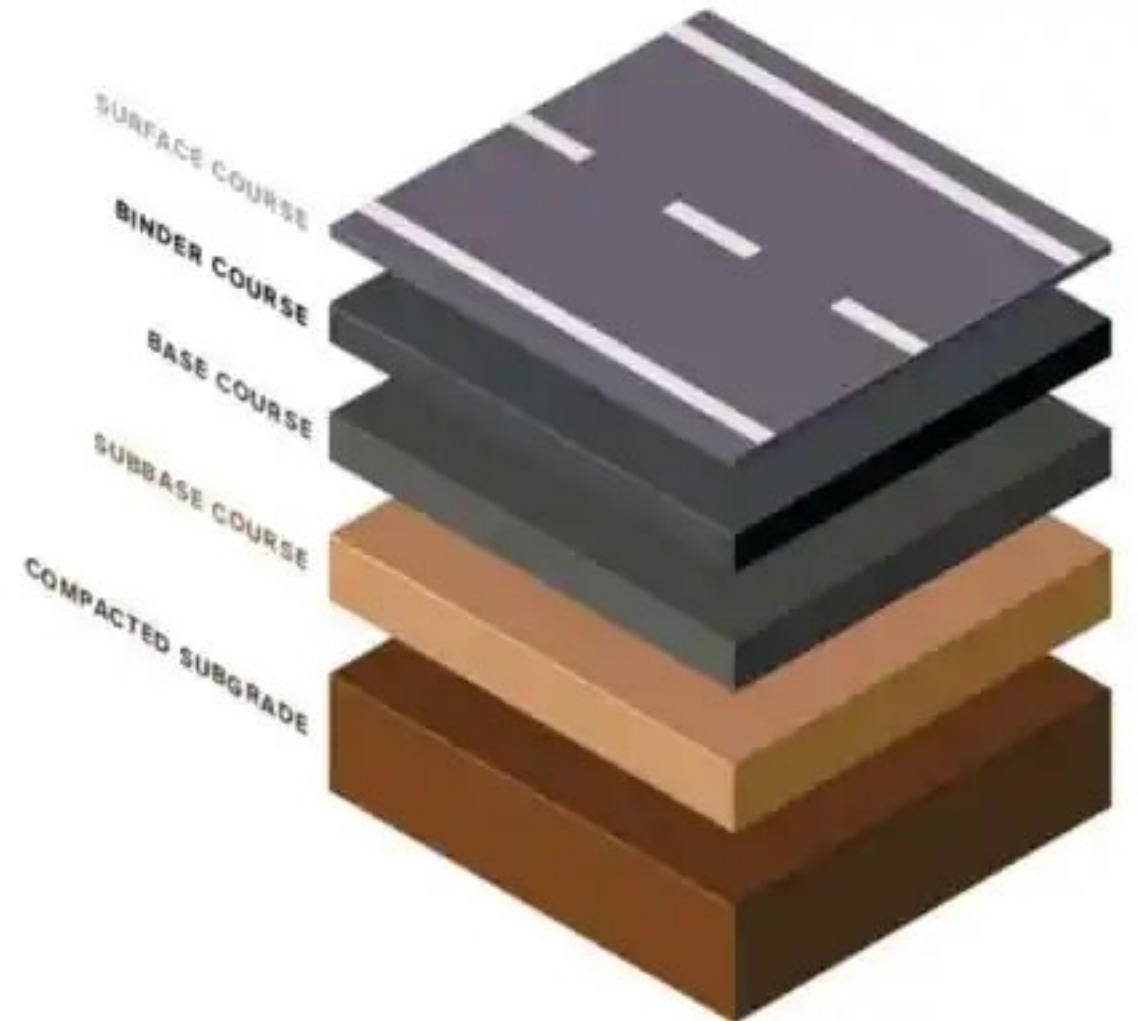


Square



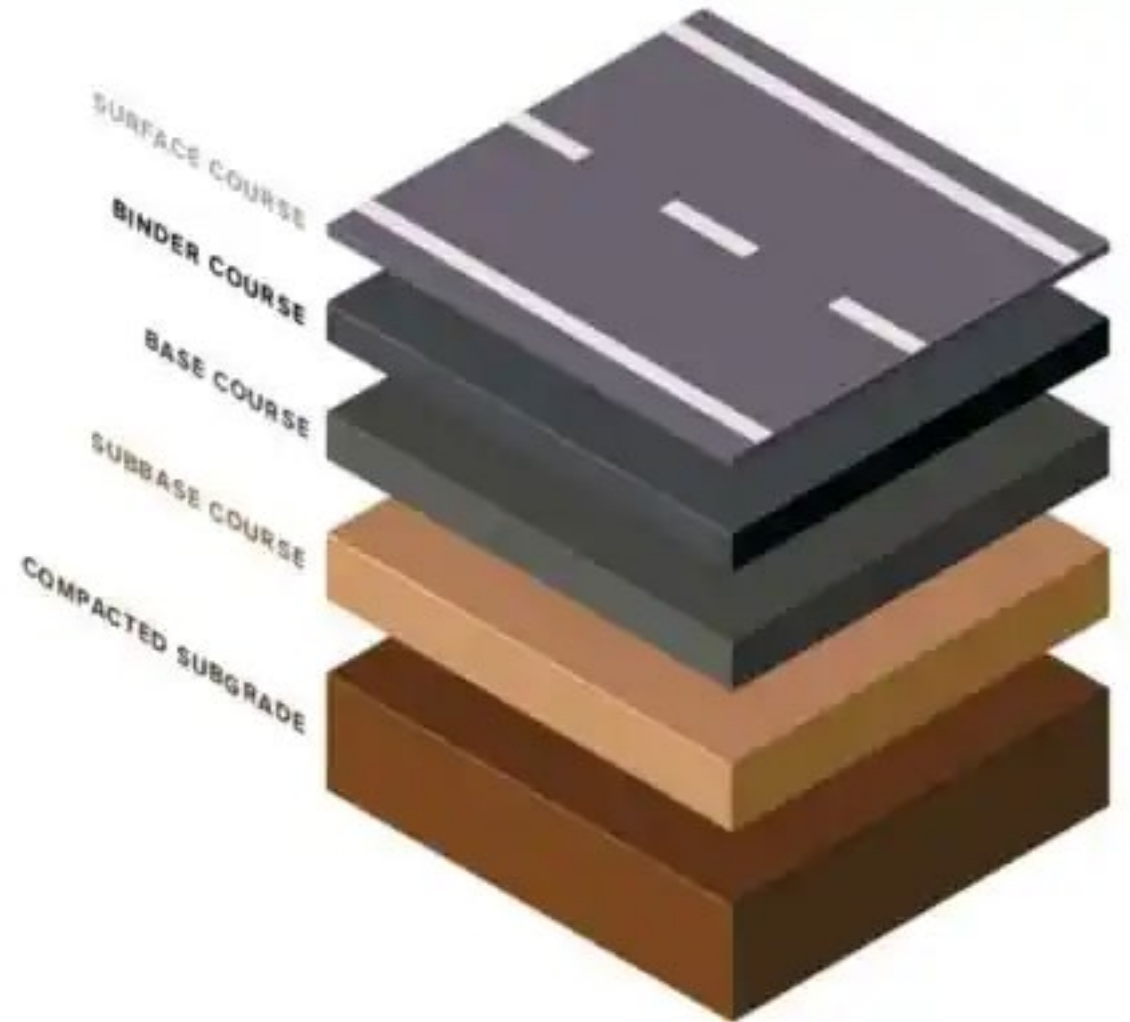
Construction of Highways

Flexible Pavement



Flexible Pavement

Surface Course ~ 25-50mm
Binder Course ~ 50-100mm
Base Course ~ 100-300mm
Subbase Course ~ 100-300mm
Compacted Subgrade ~ 150-300mm



Subgrade

Subgrade is the bottom most layer which is nothing, but natural soil layer compacted up to required depth to receive the loads coming from top layers.



Subbase Course

The Sub-base course is provided above the subgrade. If the sub-grade soil is strong and stiff, then there is no need to sub-base course



Base Course

The base course is important layer of pavement structure, and it distributes the loads from top layers to the underneath Subbase and sub-grade layers.

It provides structural support for the pavement surface



Binder Course

Binder course is constructed using aggregates and bitumen.

The function of binder course is to transfer the loads coming from surface course to the base course.



Surface Course

Surface course or wearing course is the top most layer of flexible pavement which has direct contact with the vehicular loads.

The main function of surface course is to provide skid-resistance surface, friction and drainage for the pavement.



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Asphalt

The umbrella term to describe the many different bituminous mixes available for use with the highway industry.

Bitumen, (refined from crude oil) is mixed together with aggregate, (generally crushed rock and or sand) to form a homogenous mixture which is referred to as asphalt.

SURFACE COURSE MATERIAL

Hot Rolled Asphalt (HRA)

The traditional UK trunk-road surfacing, valued where waterproofing and long life matter most.

COMPOSITION

- Dense, sand-rich asphalt
- High bitumen content
- Precoated chippings rolled into the surface

LIMITATIONS / WATCH-OUTS

- More expensive than some alternatives
- Can polish if chippings wear away
- Noisier than modern thin surfacings

ADVANTAGES / BENEFITS

- Very durable
- Excellent waterproofing
- Long service life: 20+ years
- Suitable for heavy traffic

TYPICAL USE

- Heavy-duty surfaces
- Bridge decks
- Locations where durability outweighs noise reduction

TYPICAL THICKNESS

30–50 mm

surface course

Durable · waterproof



SURFACE COURSE MATERIAL

Stone Mastic Asphalt (SMA)

A common UK surface course that combines a stone skeleton with a bitumen-rich mortar.

COMPOSITION

- Gap-graded aggregate
- High stone content
- Bitumen-rich mortar
- Cellulose or polymer fibres

LIMITATIONS / WATCH-OUTS

- Requires consistent mix control
- Best performance depends on aggregate quality

ADVANTAGES / BENEFITS

- Excellent rut resistance
- Good fatigue performance
- Good ride quality
- Lower tyre noise than HRA

TYPICAL USE

- Local authority and strategic roads
- Urban A-roads
- Roundabouts and junctions

TYPICAL THICKNESS

30–40 mm

surface course

Rut-resistant · quiet



Thin Surface Course Systems (TSCS)

Proprietary systems that have largely replaced HRA on high-speed roads.

COMPOSITION

- Thin layer design
- High PSV aggregate
- Polymer-modified binders
- Optimised aggregate grading

LIMITATIONS / WATCH-OUTS

- System-specific specification and approval
- Performance linked to proprietary design and laying quality

ADVANTAGES / BENEFITS

- Reduced traffic noise
- Excellent skid resistance
- Quick construction
- Lower whole-life maintenance

TYPICAL USE

- Motorways
- Trunk roads

TYPICAL THICKNESS

20–40 mm

surface course

High-speed roads



SURFACE COURSE MATERIAL

Asphalt Concrete (AC)

A practical general-purpose material, formerly known as Dense Bitumen Macadam in older specifications.

COMPOSITION

- Dense asphalt concrete
- Conventional aggregate and bitumen mix
- General-purpose surface course

LIMITATIONS / WATCH-OUTS

- Less rut resistant than SMA
- Generally shorter life under heavy traffic

ADVANTAGES / BENEFITS

- Lower cost
- Easy to lay
- Good all-round material for lower-volume roads

TYPICAL USE

- Residential roads
- Car parks
- Local authority roads
- Urban streets

TYPICAL THICKNESS

30–50 mm

surface course

Cost-effective



SURFACE COURSE MATERIAL

Porous Asphalt (PA)

Designed with interconnected air voids so water can pass through the surfacing layer.

COMPOSITION

Open structure with connected voids
Allows water to drain through the layer
Noise-reducing surface texture

ADVANTAGES / BENEFITS

Reduced spray and standing water
Lower tyre noise
Reduced aquaplaning risk

LIMITATIONS / WATCH-OUTS

Higher maintenance requirement
Can clog over time
Less common today than TSCS

TYPICAL USE

Where drainage and spray reduction are priorities
Selected applications rather than mainstream UK practice

TYPICAL THICKNESS

40–50 mm

surface course

Drainage · spray
reduction



SURFACE COURSE MATERIAL

Ultra-Thin Surface Course Systems (UTSCS)

Typically used as a maintenance treatment rather than as a new-construction surface course.

COMPOSITION

- Ultra-thin proprietary layer
- Applied over an existing pavement
- Designed to refresh surface characteristics

LIMITATIONS / WATCH-OUTS

- Not a structural replacement
- Best suited to maintenance where the base pavement remains sound

ADVANTAGES / BENEFITS

- Rapid installation
- Minimal traffic disruption
- Restores skid resistance
- Cost-effective maintenance treatment

TYPICAL USE

- Surface renewal schemes
- Short-duration closures
- Skid-resistance restoration

TYPICAL THICKNESS

10–20 mm

surface course

Maintenance overlay



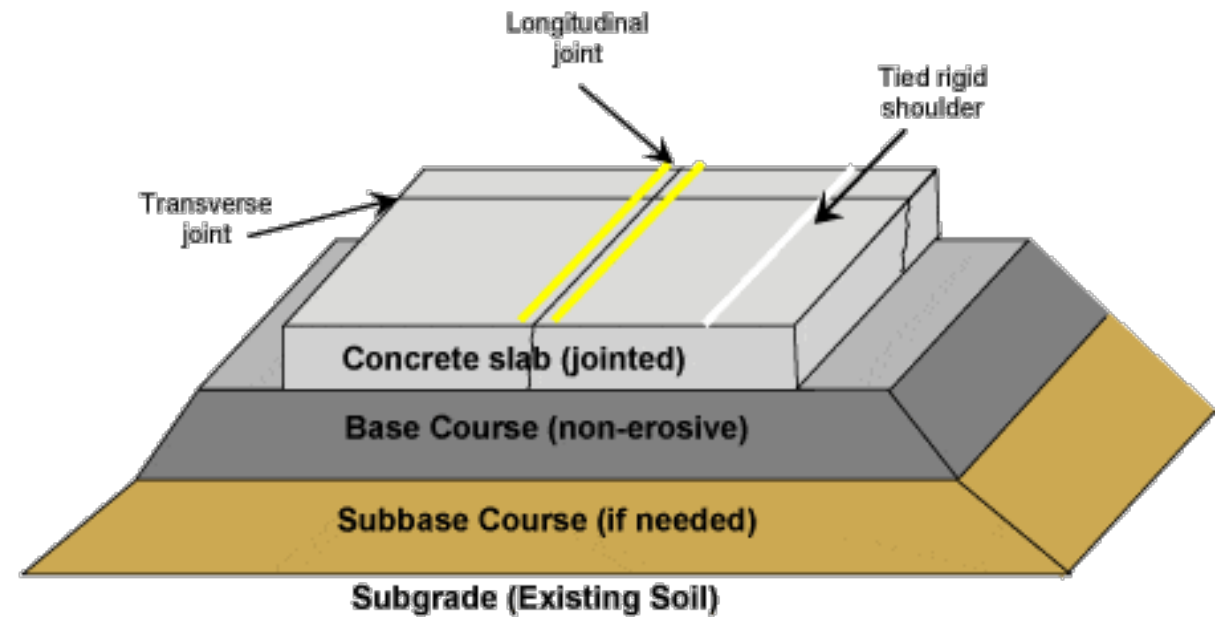
Surface course comparison

Current UK practice favours TSCS and SMA for performance, noise reduction and ease of construction; AC remains common for lower-volume roads.

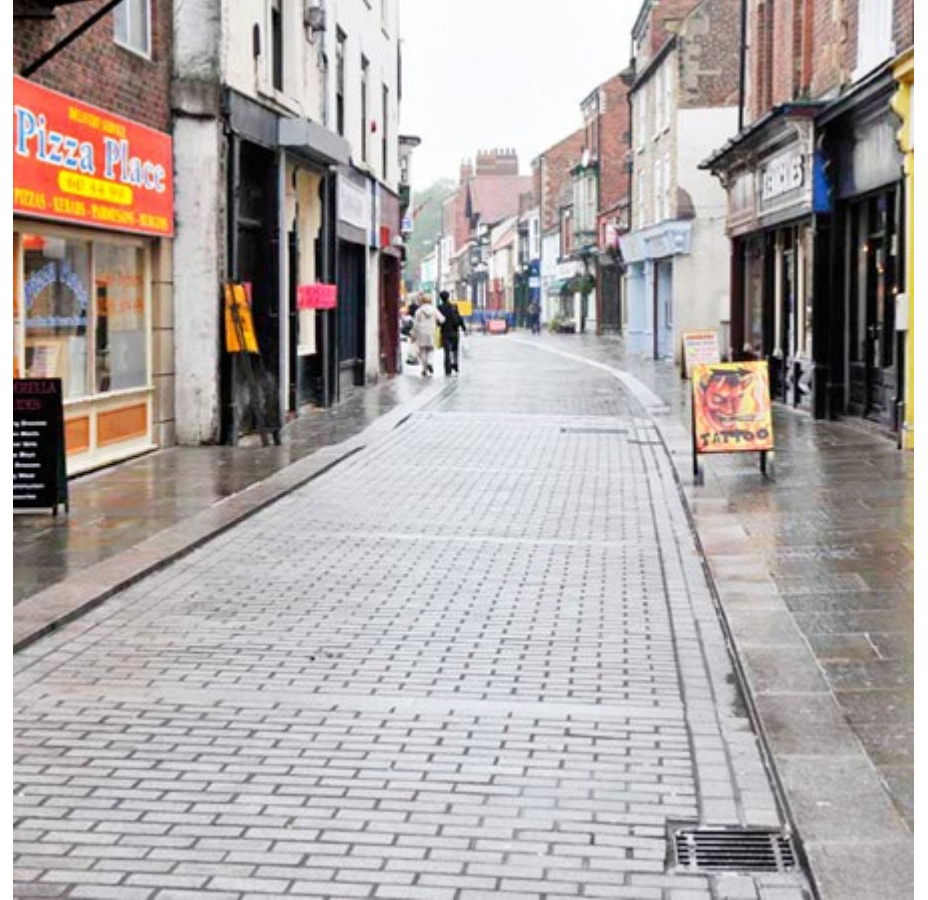
Road type	Typical surface course
Motorways	TSCS or SMA
Trunk roads	TSCS, SMA, occasionally HRA
Urban A-roads	SMA or AC
Residential streets	AC or SMA
Roundabouts and junctions	SMA for rut resistance
Bridge decks	HRA or specialist SMA

Shift in practice: HRA was once the UK standard, but TSCS and SMA now dominate new flexible pavement surface courses.

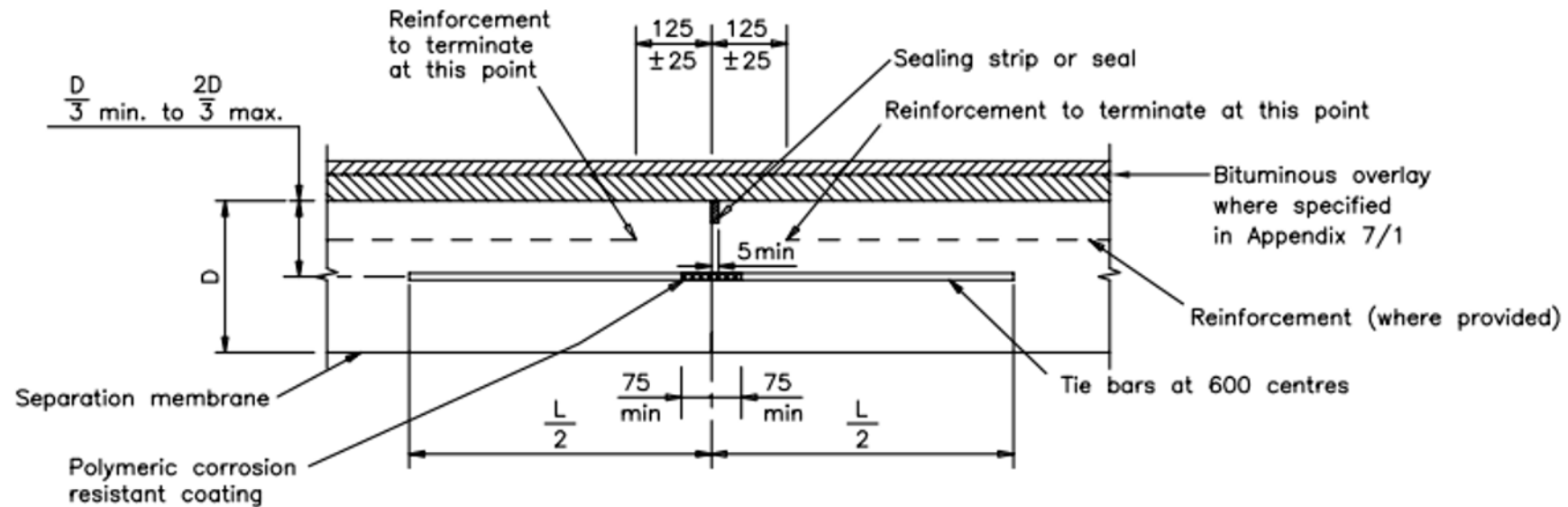
Rigid Pavement



Rigid Pavement



Rigid Pavement



TYPE 1

Longitudinal construction joint between two separately constructed unreinforced or jointed reinforced slabs

Kerbs

What is the purpose of a kerb?

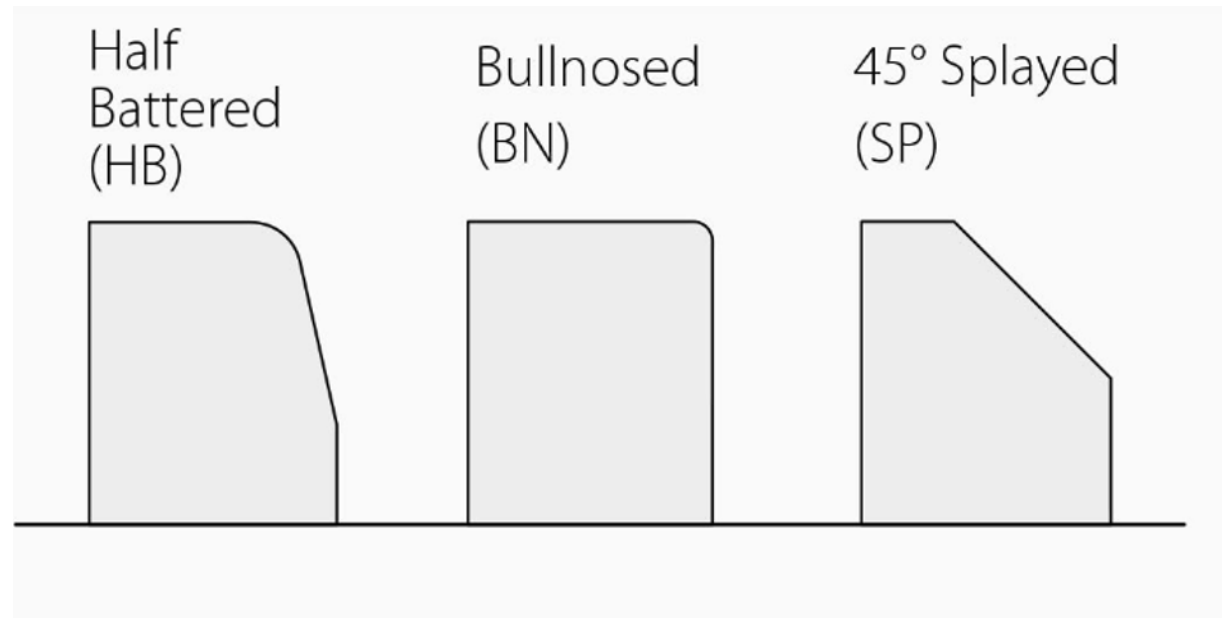
Kerbs

What is the purpose of a kerb?

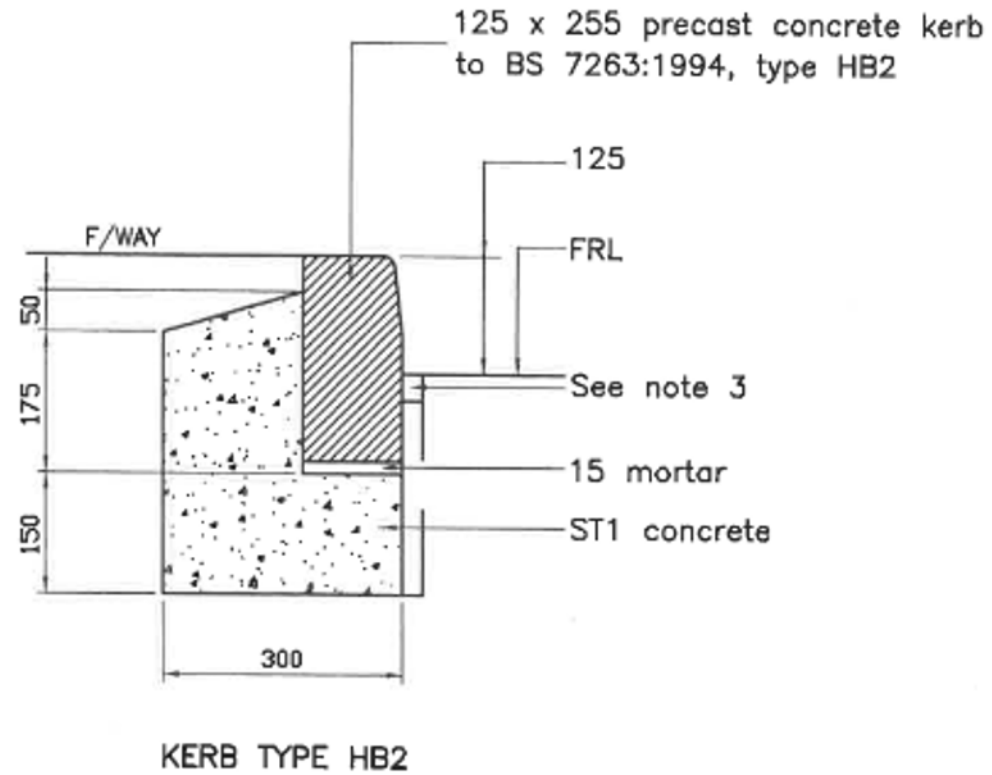
- To separate the road from adjacent footways / verges
- To contain the spread of road surfacing
- To direct surface water flow

Kerbs

For most purposes, the top of the kerb should be 100 mm above the road surface



Kerbs



Highway drainage: design objectives

01 Remove carriageway water quickly

Keep surface water moving off the road to improve safety and reduce nuisance for users.

02 Maintain pavement and earthwork life

Limit water-related deterioration so the road structure and supporting earthworks last longer.

03 Control downstream impact

Reduce flood-risk and water-quality impacts before runoff reaches the receiving environment.

04 Manage water from structures and slopes

Collect, route and discharge flows from bridges, culverts, embankments and cuttings.

THE DESIGN LENS

**Drainage is a safety,
asset-life and
environmental-
control system.**

Safety

less standing water and spray

Durability

slower pavement deterioration

Environment

controlled runoff quality and flow

Highways Drainage





Maintenance of Highways

Maintenance

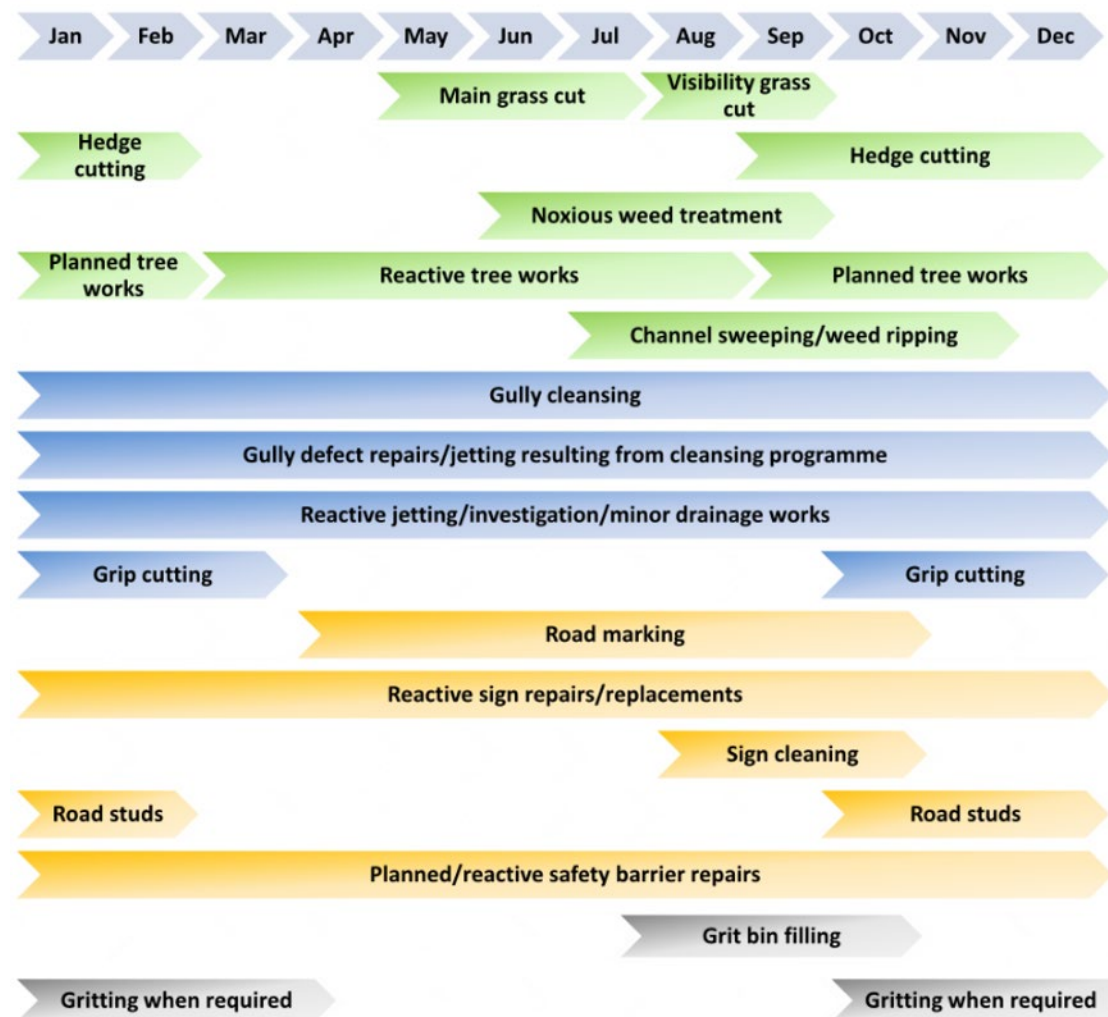
Regular maintenance can prevent defects from occurring - saving money and preventing disruption to road users

Maintenance can be classed as:

- Amenity or Cyclic
- Minor or routine
- Major or structural

Amenity / Cyclic

Routine / Preventative
Maintenance carried out to
maintain road safety.



Minor / Routine Maintenance

Patching

Reinstatement
(Every 15-20
yrs)

Surface
dressing

Haunching

Major / Structural Maintenance

Resurfacing

Overlays

Widening

Reconstruction

Causes of Deterioration

Surface weathering due to water/fuel spillage

- Leads to embrittlement and failure of the binder, with progressive loss of fine and coarse aggregate.
- Ingress of water weakens the subgrade and renders it vulnerable to frost heave.



Causes of deterioration

Traffic loading: flexing of pavements under repeated loading

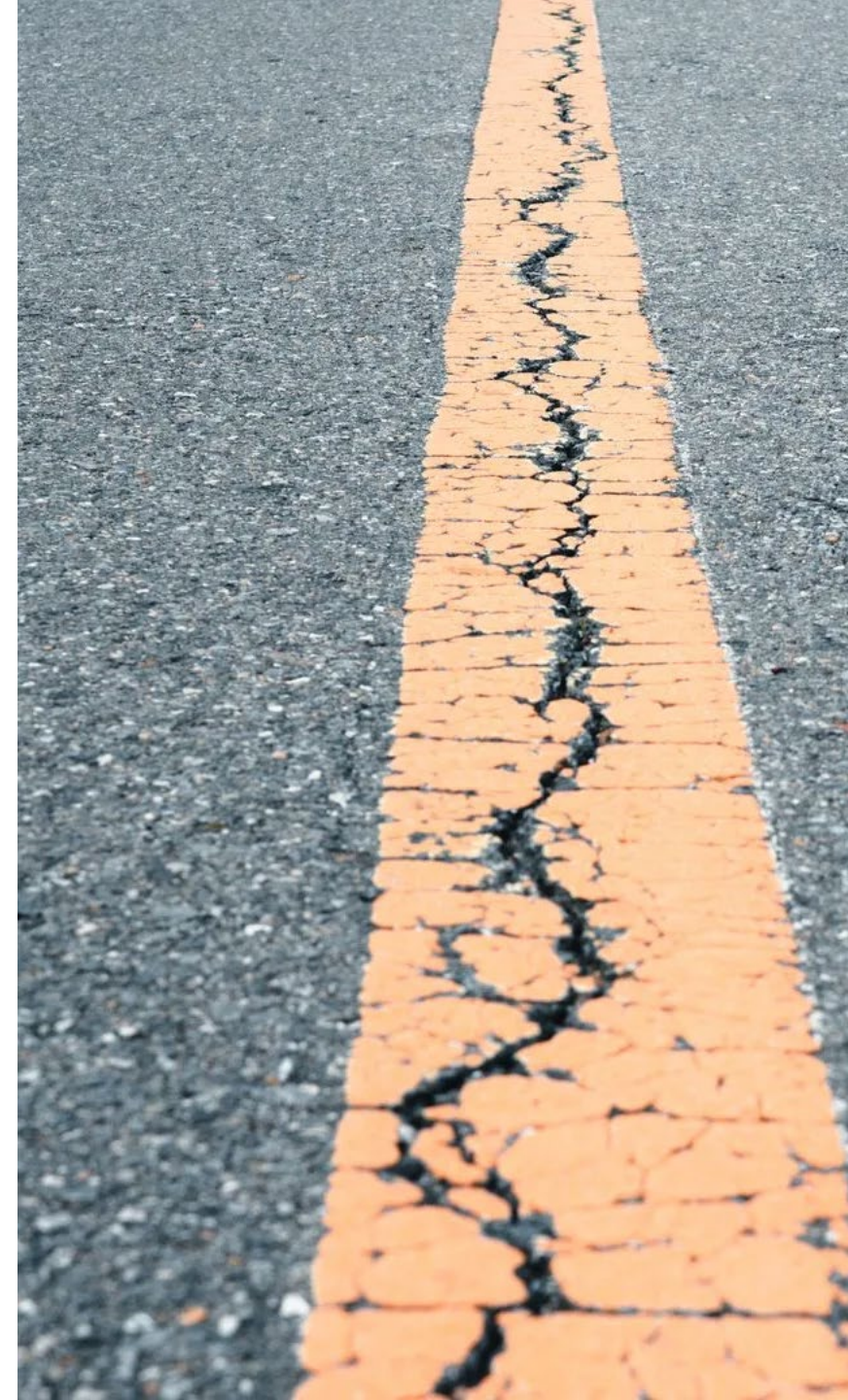
- Leads to fatigue, and structural failure, particularly over weak sub-grades and where the depth of carriageway construction is inadequate to provide sufficient spread of loads from commercial vehicles



Causes of deterioration

Thermal movement due to temperature changes between summer/winter and day/night.

- Fatigue failure occurs at reflective cracks in surfacing.



Causes of deterioration

Slippage cracking

- Slippage cracks are crescent or half-moon shaped cracks, having the two ends pointing away from the direction of traffic flow.
- They are produced when braking or turning wheels cause the pavement surface to slide or deform.
- This defect usually occurs when there is a soft, binder-rich surface mix, or a poor bond between the surface and underlying layer (e.g. basecourse).



Causes of deterioration

Reinstatement of public utility openings

- The greatest cause of surface and structural irregularity is due to public utility openings



Causes of deterioration

Alligator / Crocodile crazing

- This defect occurs primarily in the wheel tracks and is often accompanied by rutting.
- This series of interconnecting cracks are caused by fatigue failure under repeated traffic loads



Causes of deterioration

Corrugation

- This consists of a series of closely spaced ridges and valleys, or ripples, occurring at fairly regular intervals, usually less than 3m apart along the pavement.
- This type of fault is usually caused by traffic action, particularly braking and accelerating on a soft surface, or by an unstable pavement foundation.



Causes of deterioration

Rutting

- A rut is a surface depression in the wheel tracks.
- Ruts are usually most noticeable after rainfall, when the wheel tracks are filled with water.
- Rutting results from traffic loading concentrated on a narrow width of the carriageway. Significant rutting can lead to major structural failure of the pavement.



Causes of deterioration

Potholes

- Relatively small (usually less than 0.9 m in diameter) bowl-shaped depressions in the pavement surfacing.
- They have sharp edges and vertical sides near the top of the hole.
- Potholes are produced by traffic abrading and dislodging small pieces of the surfacing, usually when the binder has become embrittled or is subject to stripping in the continued presence of water.
- Their growth is accelerated by water collecting inside the hole.
- The condition is progressive in both area and depth, ultimately affecting the road foundation if no corrective action is taken.

