Geometric Design

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Geometric Design

- Design Speed
- Visibility
- Horizontal Alignment
- Vertical Alignment

Design Speed

- Key parameter informing geometric design
- DMRB: Design speeds from 42 kph to 120 kph
  - Related to physical constraint & mandatory speed limit
- DMURS covers range from 10 kph to 60 kph
  - Related to function & context

PEDESTRIAN PRIORITY — VEHICLE PRIORITY

FUNCTION					
ARTERIAL	30-40 KM/H	40-50 KM/H	40-50 KM/H	50-60 KM/H	60-80 KM/H
LINK	30 KM/H	30-50 KM/H	30-50 KM/H	50-60 KM/H	60-80 KM/H
LOCAL	10-30 KM/H	10-30 KM/H	10-30 KM/H	30-50 KM/H	60 KM/H
	CENTRE	N'HOOD	SUBURBAN	BUSINESS/ INDUSTRIAL	RURAL FRINGE

CONTEXT

Visibility

Stopping Sight Distance

- SSD determined from the equation:

$$SSD = vt+(v^2/2d)$$

Where:

v = vehicle speed

t = driver perception-reaction time

d = deceleration rate

- DMRB Values:
  - Perception-Reaction time: 2 seconds
  - Deceleration rate: 0.25g = 2.45 m/s^2 - stopping on snow

- Research from UK *'Manual for Streets':*
  - 90th percentile reaction time of 0.9 seconds
  - Average deceleration rate is 4.5 m/s^2 – firm braking
  - Rates of 0.45g (4.41 m/s^2) achievable in wet weather
  - Buses/HGV's required to achieve 0.36g (3.5 m/s^2)

Visibility

- DMURS SSD's are based on:
  - Reaction time of 1.5 seconds
  - Deceleration rate of 0.45g (4.41 m/s^2) in general
  - Bus/HGV deceleration rate of 0.375g (3.68 m/s^2)

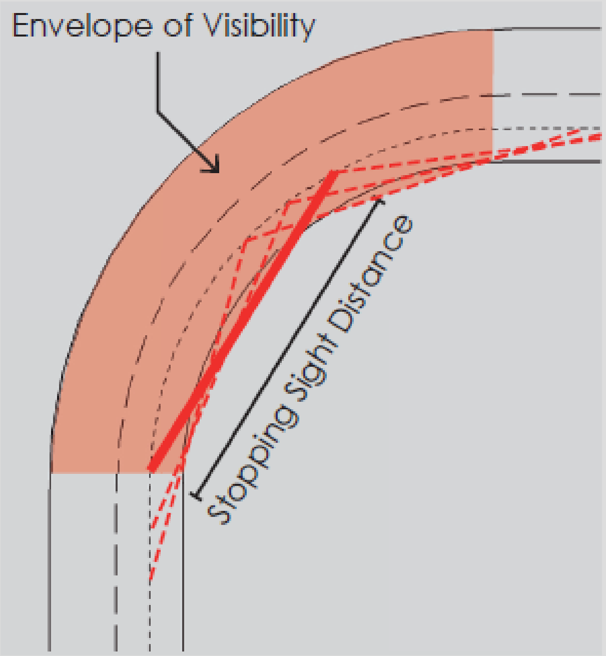
Design Speed	10	20	30	40	50	60
DMRB	-	-	-	50	70	90
DMURS	7	14	23	33	45	59
DMURS (Bus)	8	15	24	36	49	65

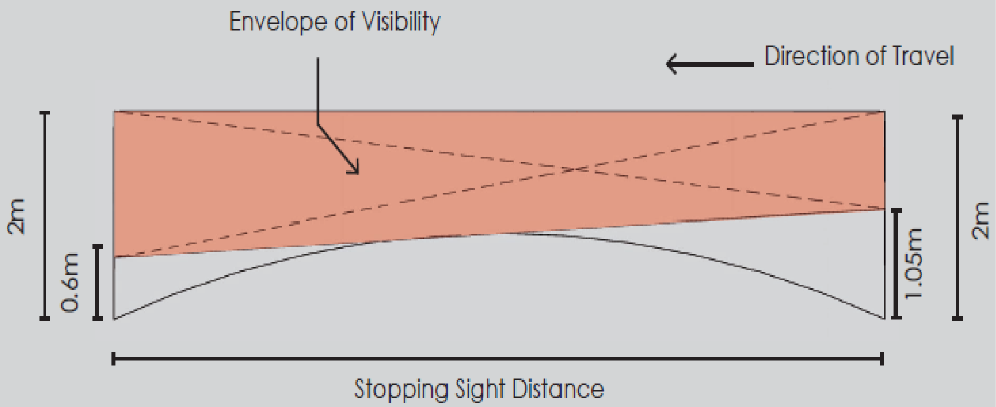
Stopping Sight Distances (m)

Visibility

Forward Visibility

- Distance along a street a motorist can see
- Min. allowable equates to SSD for the relevant Design Speed
- Reduced SSD's can assist in achieving 'self-regulating' streets.



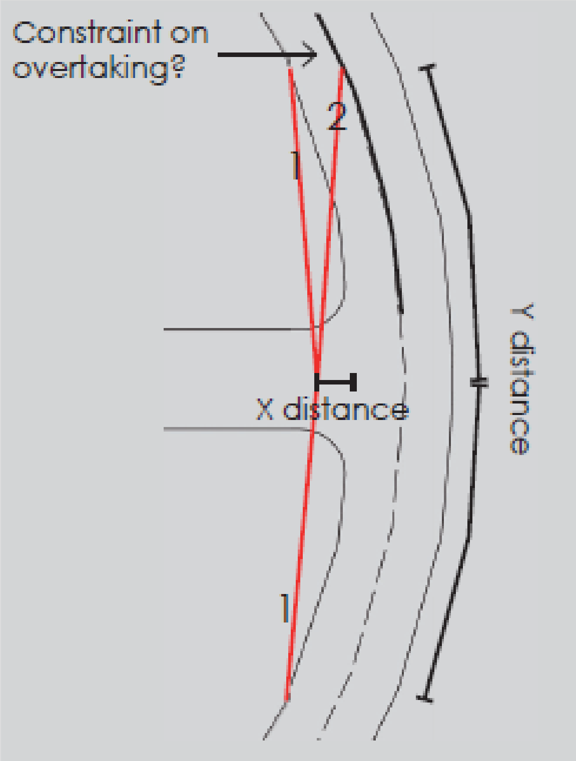


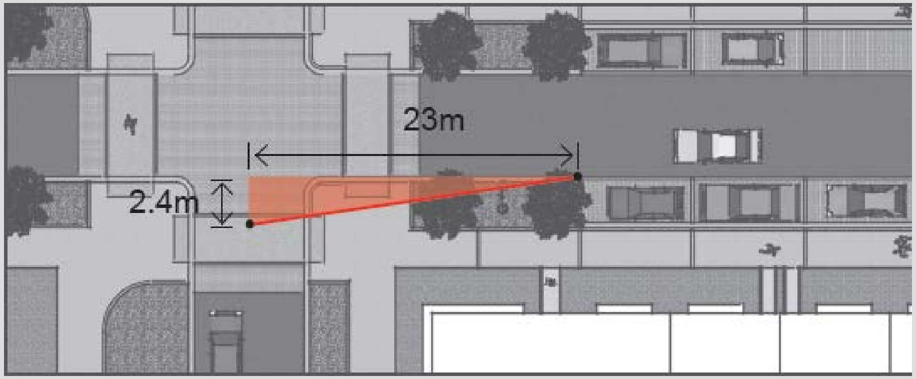
Visibility

Junctions

- 'x' Distance
  - Set back distance from carriageway edge
  - 2.4 metres generally
  - 2.0 metres allowable in difficult circumstances
  - Measured along side road centre line for convenience

- 'y' Distance
  - Distance visible along street edge
  - Corresponds to SSD for a given design speed
  - Generally measured from nearside carriageway edge





Horizontal Alignment

- Consists of a series of straight lines joined by curves
- Curves are main focus of HA design
- Centrifugal force counteracted by:
  - Friction between tyres & road surface
  - Superelevation of the carriageway
- Radius is determined from the formula:

$$e + \mu = V^2/127R$$

Where:

e = superelevation

μ = side friction factor

V = velocity

R = radius of curvature

- Traditionally, a 55/45 split between friction and superelevation assumed

Horizontal Alignment

- Previous guidance has aimed to maintain speed and comfort
- Problematic in urban areas:
  - Superelevation often impractical or undesirable
  - Consequent need to design with little or no superelevation
  - Drainage crossfalls result in adverse camber
- However, drivers in urban areas have a higher threshold for discomfort through conditioning
- Allows curves to be designed utilising friction alone to counteract centrifugal forces
- AASHTO 'Green Book':
  - Side friction factors for urban streets
  - Moderate level of discomfort
  - Reasonable margin of safety against skidding

Horizontal Alignment

- DMURS Standards
  - Promote self-regulation of speed
  - Based on reduced comfort criterion

- 2 options:
  1. Min. radius with adverse camber of 2.5%
  2. Min. radius with superelevation of 2.5%

Design Speed	10	20	30	40	50	60
DMRB	-	-	-	360	510	720
DMURS 1	-	11	26	56	104	178
DMURS 2	-	-	-	46	82	136

Horizontal Curve radii (m)

Vertical Alignment

- VA consists of a series of straight line gradients joined by curves, usually parabolic

- 2 types:
  - Crest curves
  - Sag curves

- Critical parameter for design is the length, L, of a curve, determined using:

$$L = K*a$$

Where:

K = constant of curvature

a = algebraic change in gradient

- DMURS provides K-values for crest & sag curves

Vertical Alignment

Vertical Crest Curve K-Values

- Designed to maintain forward visibility equal to SSD
- 2 possible scenarios:
  - SSD < curve length
  - SSD > curve length

Design Speed	10	20	30	40	50	60
DMRB	-	-	-	6.5	10	17
DMURS	-	-	-	2.6	4.7	8.2

K-Values for Crest Curves

- Cover changes in gradient up to 12%
- Where design speed is < 40 kph, specific crest curve design is not required

Vertical Alignment

Vertical Sag Curve K-Values

- 3 considerations:
  - Driver comfort
  - Clearance from structures
  - Night-time conditions

- DMURS K-Values based on the driver comfort criterion

Design Speed	10	20	30	40	50	60
DMRB	-	-	-	6.5	9	13
DMURS	-	-	2.3	4.1	6.4	9.2

K-Values for Sag Curves

- Comfort criterion of 0.3 m/s^2 maximum vertical acceleration – equal to one step below desirable minimum in DMRB

Vertical Alignment

Gradients

- Comfort of road users determining factor in urban areas
- Part M – Max. gradient of 1 in 20 preferred – 5%
- In hilly terrain, or in difficult circumstances:
  - Max. gradient for wheelchair users of 8.3%
  - Limited to short distances
  - May require intermediate landings
- If gradients > 8.3% unavoidable, accessible routes for VRU's to be considered at network level
- Min. longitudinal gradient of 0.5% to aid drainage

Conclusion

- DMURS Standards based on geometrical and physical principles – no ‘new’ theory applied
- DMURS advocates a balanced approach to street design
- Geometric standards one of a package of measures within DMURS, and cannot be applied in isolation