Welcome back to the CAREC "Road Safety Engineering" Workshop

- for professionals in Kazakhstan

Module 6

- SIGNS, LINES AND DELINEATION

- SAFETY AT ROAD WORKS

- SAFER RURAL ROADS

Thursday 28th October 2021

CAREC

Central Asia Regional Economic Cooperation Program

Module Six: Signs, road works, and rural roads.

Outlining key issues for you to think about with road signs and delineation

Detailing how to make your road work sites safer for all.

Outlining key safety issues for rural roads

SIGNS & DELINEATION

Objectives:

- the categories of signs
- the 6 C’s of good signage
- encourage good delineation

We need to assist road users with their decision making
(to make correct decisions, quicker)

Use standard applications where possible

- Follow your country's standards and guides
- But always question whether "standards" are safe
- Judgment

Be consistent across the road network

- Consistent use of signs and symbols
- Consistent level of signage: not too little or too much

Put yourself in the shoes of the road user

- Help them in the driving task
- Consider the unfamiliar driver
- Do not forget pedestrians & bicyclists

3 categories of road signs

1 Regulatory (mandatory)

2 Warning (cautionary)

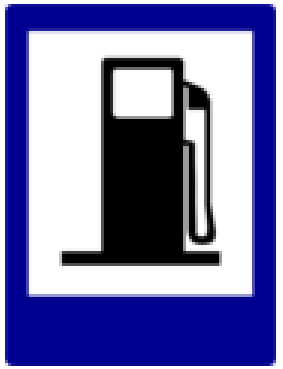
3 Guide (information)

- Direction
- Tourist
- Services
- Traffic instruction
- Traffic information

Guide (Tourist) Signs

Guide (Services) Signs

Guide (information)
Direction
Tourist
Services
Traffic instruction
Traffic information



The 6C's of good signs

Conspicuous - easily seen
Clear - legible, able to be read in time
Concise - as few words as possible
Comprehensible – understandable
Credible – believable
Correct – must be the correct sign

- Conspicuous
- Clear
- Concise
- Comprehensible
- Credible
- Correct

- Conspicuous
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- Correct

Longitudinal Separation

Locate signs a minimum 0.6 x design speed apart

Urban areas: 0.6 x 50 km/h: 30 m

Rural areas: 0.6 x 80 km/h: 48 m

Freeways/highways: 0.6 x 100 km/h: 60 m

Advance Sign Placement

Place advance warning signs before the hazard/ action point:

Urban (50 km/h) :	80 to 120 m
Rural (80 km/h):	120 to 180 m
E'ways/h'ways (100 km/h):	180 to 250 m


Maintenance of signs is important

Delineation is essential – and best when it is consistently applied along a route

- Better to have 3-star delineation consistently, than a mix of 1 star and 5-star sections.
- Theft, vandalism, natural damage (landslides).
- Decide if it is better to use more robust (less forgiving) devices in your country. Motorcycles?
- Some countries have many pedestrians and small numbers of vehicles in rural areas; some have the opposite.

Delineation

- Guideposts

- Raised Reflective Pavement Markers (cats eyes)
- Hazard Markers

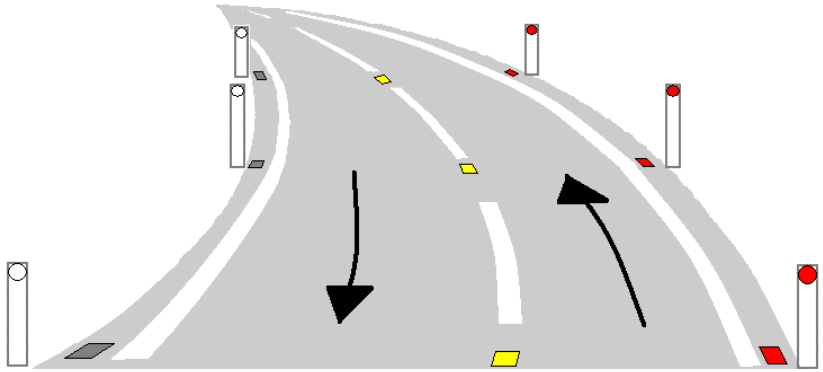
- Chevron Alignment Markers (CAMs)

- Reflective Width Markers

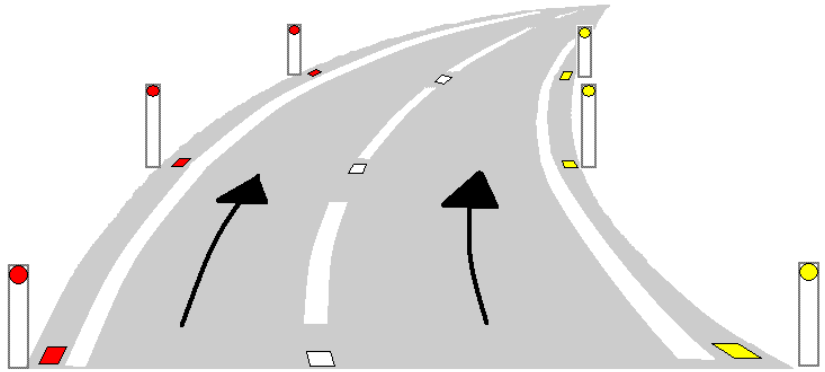
Guideposts

- White post 1 metre high, 100 mm wide
  - Double sided on a two-way road
  - Retro-reflective delineator
  - Red on the driving side
  - White on the opposite side
  - Lateral placement:
    - 150 mm clear of outer edge of shoulder
    - 1.2 to 3.0 m from edge of traffic lane
    - Keep the lateral space consistent

RRPM and guidepost delineator colours

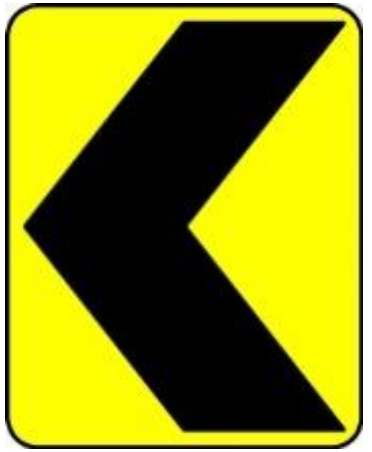


Two-way roadway



One-way roadway

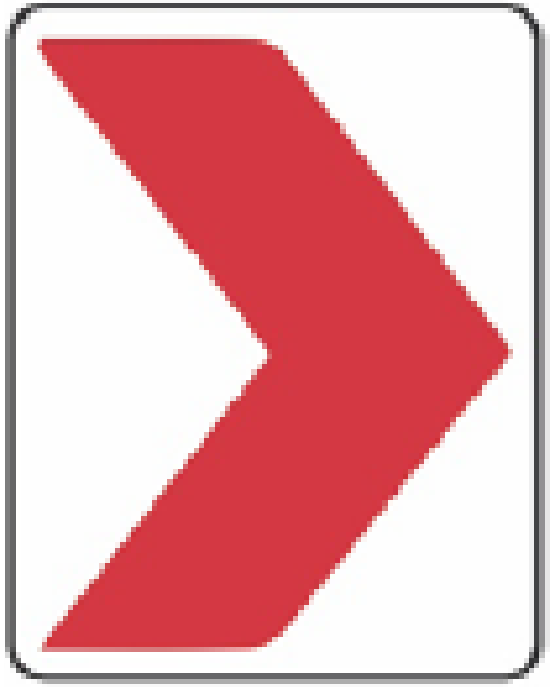
Chevron Alignment Markers (CAM's)



- Keep CAMs for substandard curves only
- Only place on outside of curve

- Always show CAM's for both directions
- Minimum of 3 CAMs in each direction

- Drivers should be able to see 3 CAMs at all times
- Space them evenly (avoid driveways, lanes, obstructions)



Chevron Alignment Markers (CAM's)


005 B 257


CAMs are for use around the outside of curves – not on inside!

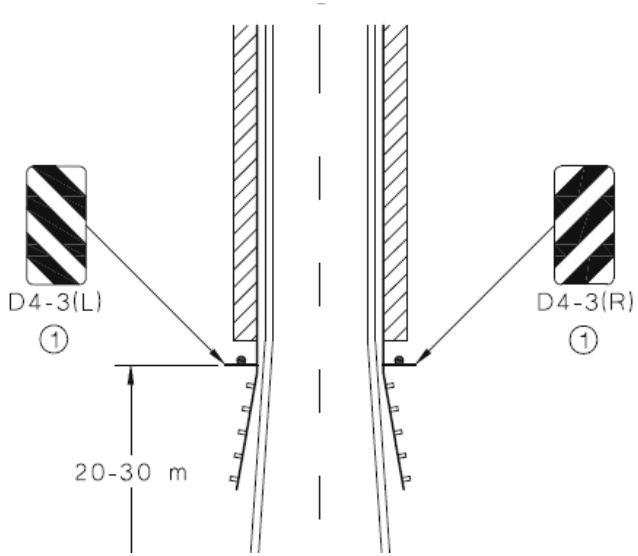
Tactile edge lines help to alert drivers when they start to drift off high speed roads.

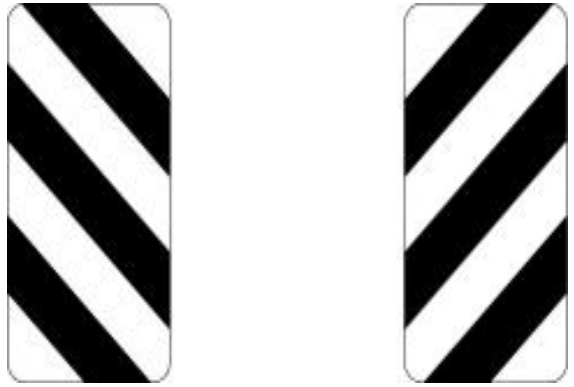
They reduce run-off-road crashes by 50%

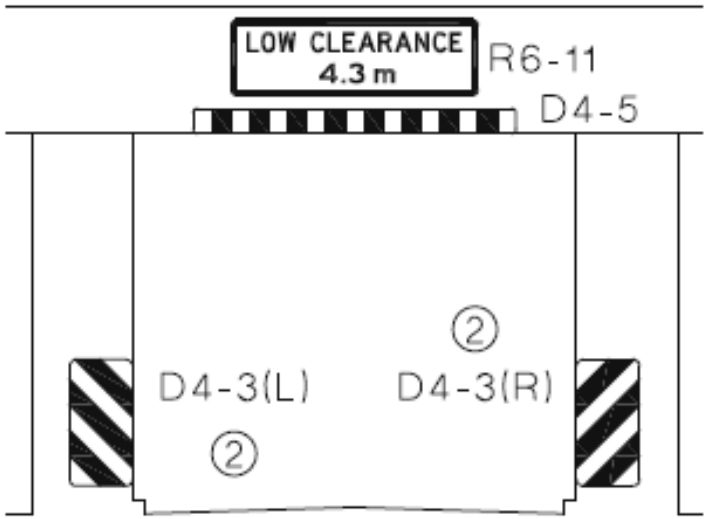

If snow ploughs will damage thermoplastic bars, use “impressed markings”
50% CRF for run-off-road crashes

Width Markers

- Culverts
- Bridge piers
- Bridge end posts
- Railway level crossings







Conclusion – signs and delineation

- Signs and markings are important to regulate, warn and guide road users

- Remember the 6 C's:
  Conspicuous, Clear, Concise, Comprehensible, Credible and Correct

- Keep your signs "positive" - tell drivers what they can/must do (rather than what they cannot do!)

- Bad signing can lead to driver distraction, lack of warning, and then misunderstanding – and sometimes, crashes.

Road safety at road works

CAREC

Central Asia Regional Economic Cooperation Program

Objectives:

- To explain why safety at road works is important.
- To outline essential points for improved safety at road works.

HOW MANY PEOPLE ARE INJURED OR KILLED IN ROAD CRASHES AT ROAD WORKS IN YOUR COUNTRY EACH YEAR?

Unfortunately, we do not know for sure……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Road crashes at road work sites are a serious problem

1. Road users have three times the risk of a serious crash in a road work zone compared with other parts of the road network (USA)

2. Studies in Finland and Slovenia showed that ‘motorists are up to five times as likely to be injured when travelling through a work zone’

IMPROVING WORKER SAFETY THROUGH BETTER VISIBILITY
Agota Berces,
Technical, Regulatory and Business Development Manager
3M Traffic Safety Systems Division, Sydney, NSW, Australia

Road crashes at road work sites are a serious problem

3. German research has shown that approximately one quarter of collisions happening on national routes occur at work zones.

4. Research has also identified that road works that take longer and extend over longer distances have lower crash rates as opposed to short term works in short length zones.

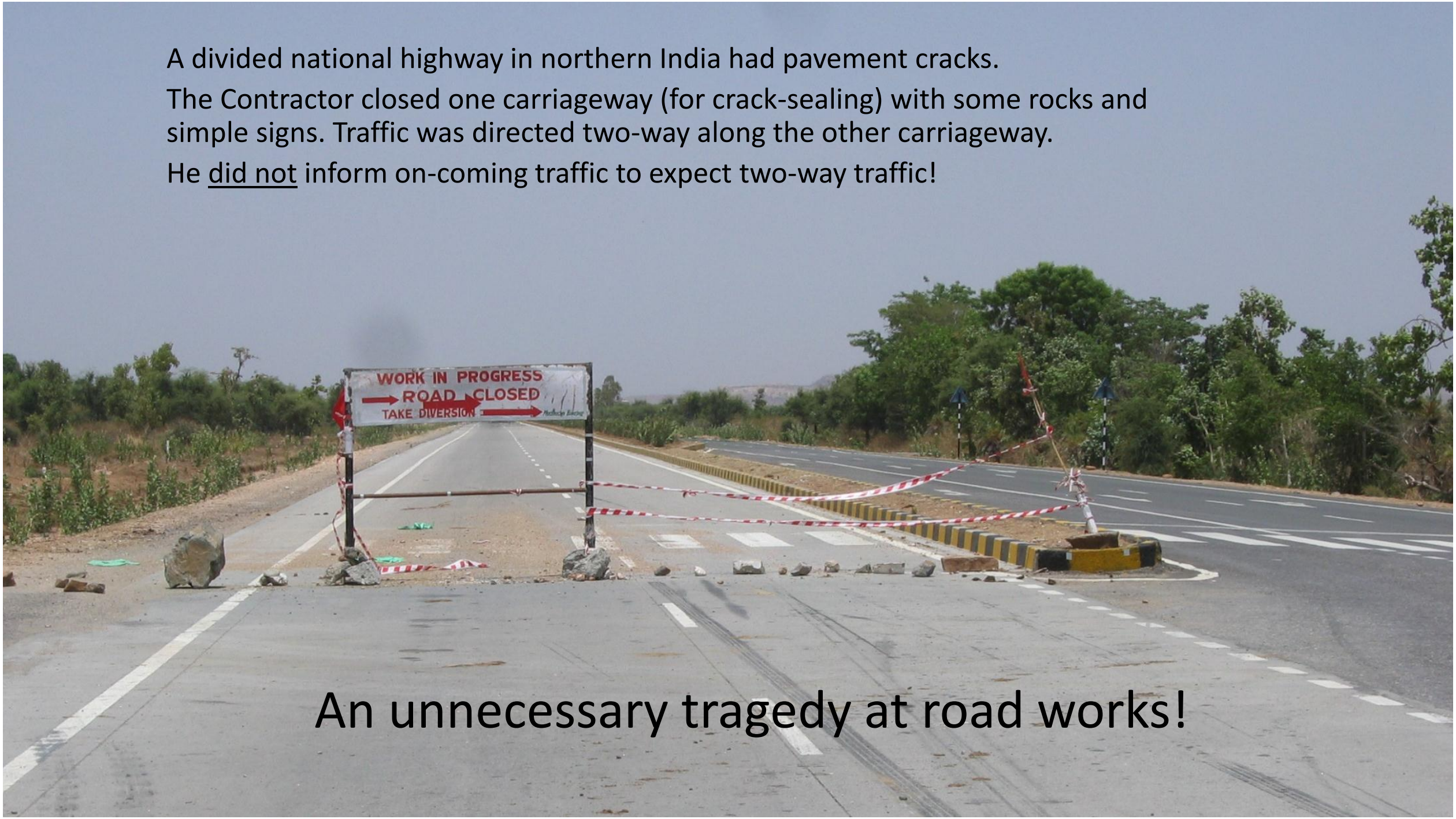
IMPROVING WORKER SAFETY THROUGH BETTER VISIBILITY

Agota Berces,
Technical, Regulatory and Business Development Manager
3M Traffic Safety Systems Division, Sydney, NSW, Australia

A divided national highway in northern India had pavement cracks.

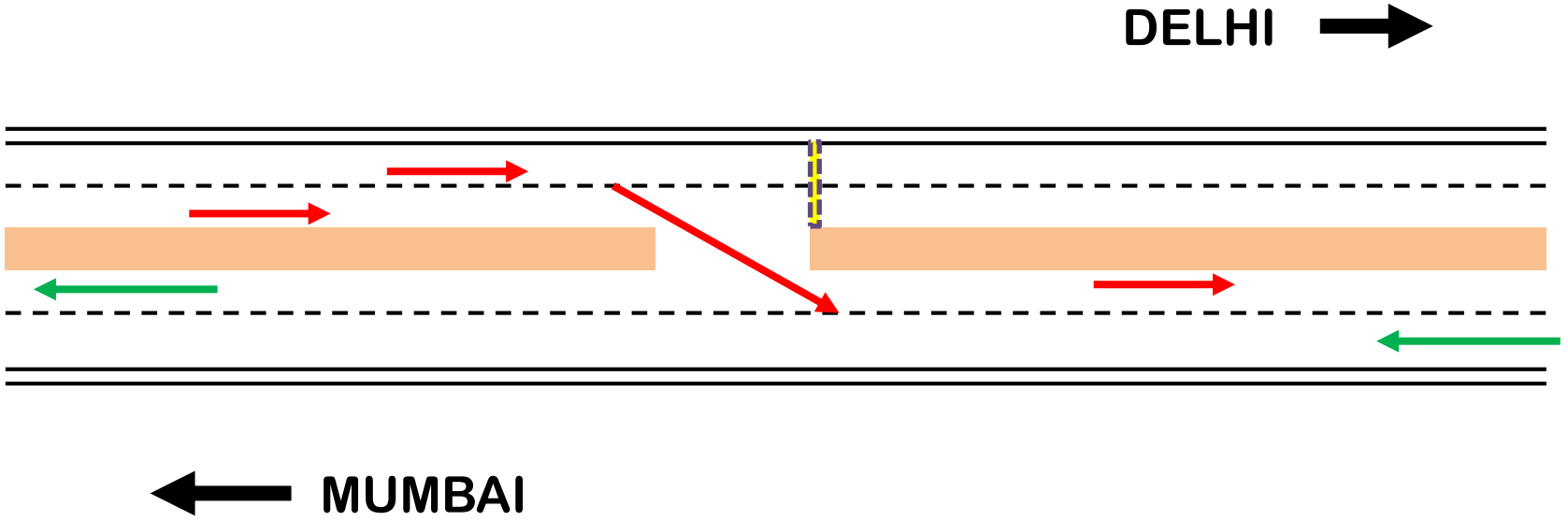
The Contractor closed one carriageway (for crack-sealing) with some rocks and simple signs. Traffic was directed two-way along the other carriageway.

He <u>did not</u> inform on-coming traffic to expect two-way traffic!



An unnecessary tragedy at road works!

A tragedy waiting to happen……



The NH 76 was a divided highway (2 carriageways). A contractor had closed the Delhi bound carriageway for maintenance (crack sealing).


DIVERSION
AHEAD
200 M
GO SLOW
Madhucon Binapuri JV
NH
76


WORK IN PROGRESS
ROAD CLOSED


WORK IN PROGRESS
ROAD CLOSED
TAKE DIVERSION


What is missing?


EXPRESS SERVICE
What is missing?


What happened?

A fatal head-on collision


HO RN PLE ASE
USE DIPPER AT NIGHT
TELCO
STOP


Five men killed

A few days later…signs placed to face the truck's direction of travel. Too late to prevent five deaths!

Could a similar situation exist on one of your highways?

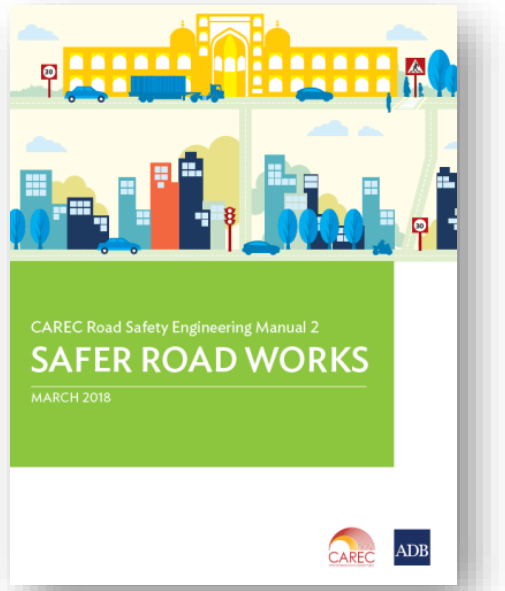
Work sites are planned and managed by engineers.

Any safety concerns at a road work site have been created by engineers!

It is up to engineers to make their work sites safe for workers and road users.

Always look at your road works through the eyes of the drivers/riders – not just as an engineer!

Road works <u>should</u> not surprise any driver or rider!

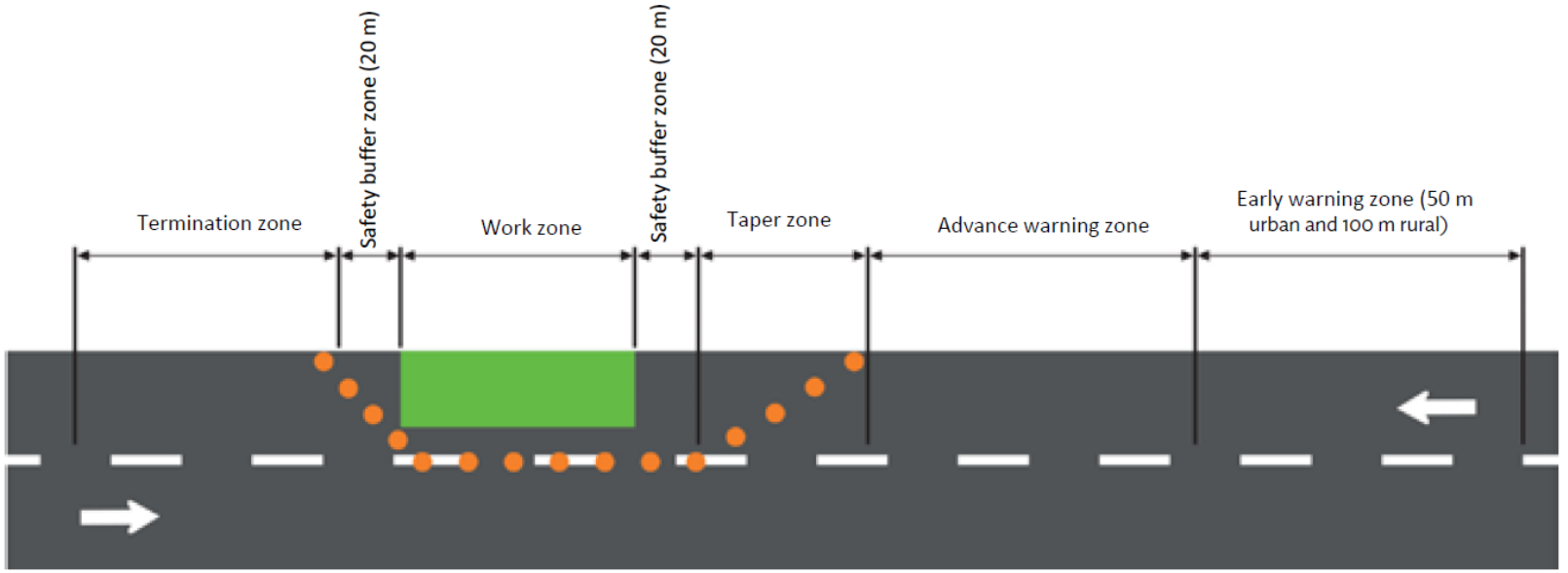


What is a TMP?

A traffic management plan (TMP) shows clearly all the signs, barriers, barricades, and other devices to be installed and maintained at a worksite for the duration of the works. If work has several stages, there should be a TMP developed for each stage expected to last longer than 1 week.

THE SIX ZONE CONCEPT

Figure 4: The Six-Zone Concept



m = meter.

Note: The traffic management plan is for one direction of travel only.

Source: Asian Development Bank.

The "Zone Concept" is a method of breaking a work site down into 6 individual zones.

The Six Zone Concept

1 Early Warning Zone – the first zone, in which signs are placed to alert approaching drivers/riders of the presence of road works ahead.

2 Advance Warning Zone – alerts drivers/riders of the Work Zone ahead. It uses advance warning signs and regulatory signs to warn users of the Work Zone ahead, and to regulate their behavior.

3 Taper Zone – is used if motorists are required to move from their lane to pass around a Work Zone.

4 Safety Buffer Zone - is a longitudinal safety buffer immediately in advance of, and beside, the work area. It is to be at least 20m in length; it is kept free of equipment, materials and workers.

5 Work Zone – is the area in which the works are carried out; it is set aside for workers, equipment and materials.

6 Termination Zone – is the zone where traffic resumes normal operations after passing the Work Zone (the last of the six zones).

THE LENGTH OF EACH ZONE IS DETERMINED BY THE MAXIMUM OPERATING SPEED ON THE ROAD WHERE WORKS ARE TAKING PLACE.

Refer to the Tables in the
CAREC manual

The taper zone length is based on:

- width of lane to be closed is typically 3.5 m,
- diverge taper length is equivalent to 1.0 m lateral shift,
- merge taper length equivalent to 0.5 m lateral shift, and
- use the operating speed of traffic to guide the taper length.

Table 6: Recommended Lengths of Taper (Transition) Zones

Approach Speed Entering the Taper Zone (km/h)	**Diverge Taper** (m)	**Merge Taper** (m)
40	50	90
50	50	100
60	60	120
70	70	140
80	80	160
90	90	180
100	100	200

Advance warning zones

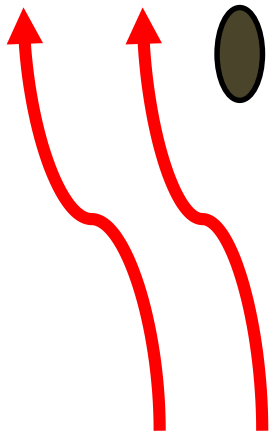
Table 5: Minimum Length of Advance Warning Zones

Approach Speed (km/h)	Length of Advance Warning Zone (m)	
	Desired Speed at the End of the Advance Warning Zone	
	40 km/h	0 km/h (STOP)
50	30	75
60	60	100
70	120	160
80	170	225
90	200	295
100	250	370

Two types of taper zones

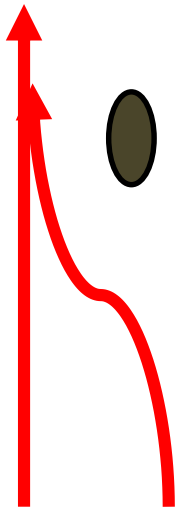
DIVERGE

Where traffic moves sideways to the left or right to pass the Work Zone



MERGE

Where two lanes of traffic combine (merge) into one to pass the Work Zone




SLOW

Use a 40 km/h speed limit through work sites – but only when workers are on-site and within 1.5m of traffic

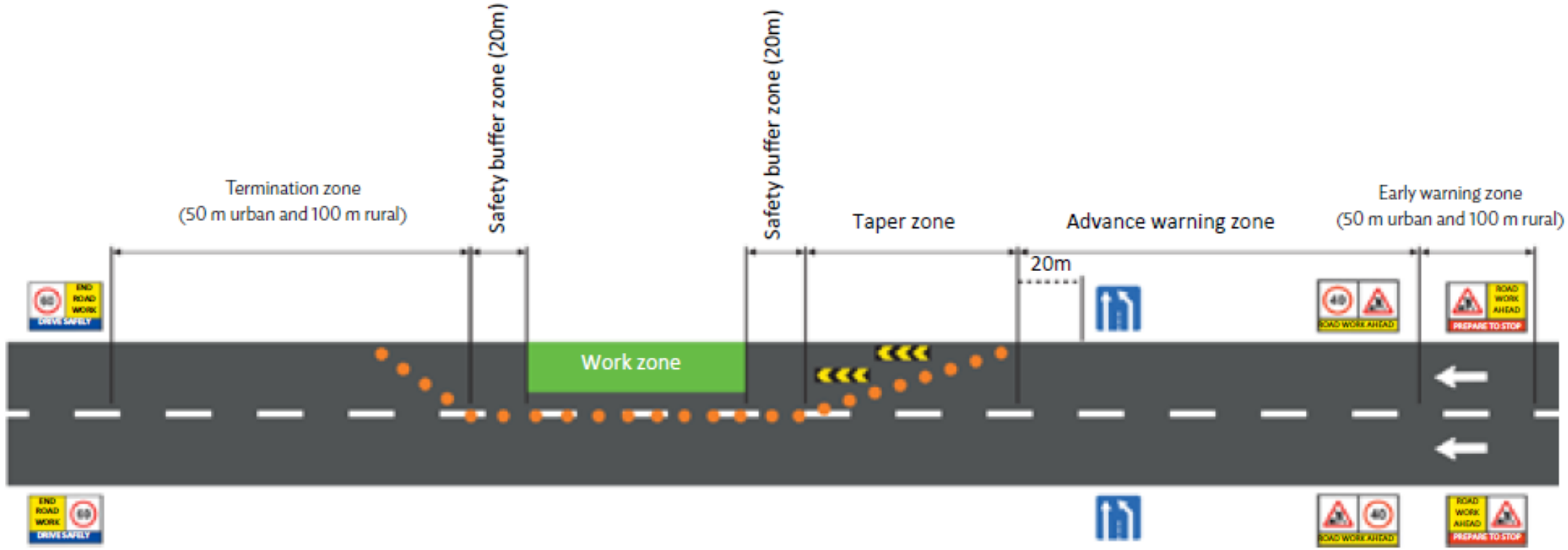
Figure 13: A Reduction in the Available Road Width but with Sufficient Width for Two-Way Traffic

m = meter.

Note: The traffic management plan is for one direction of travel only.

Source: Asian Development Bank.

Figure 17: Closure of the Right-Hand Lane of a Multilane Carriageway



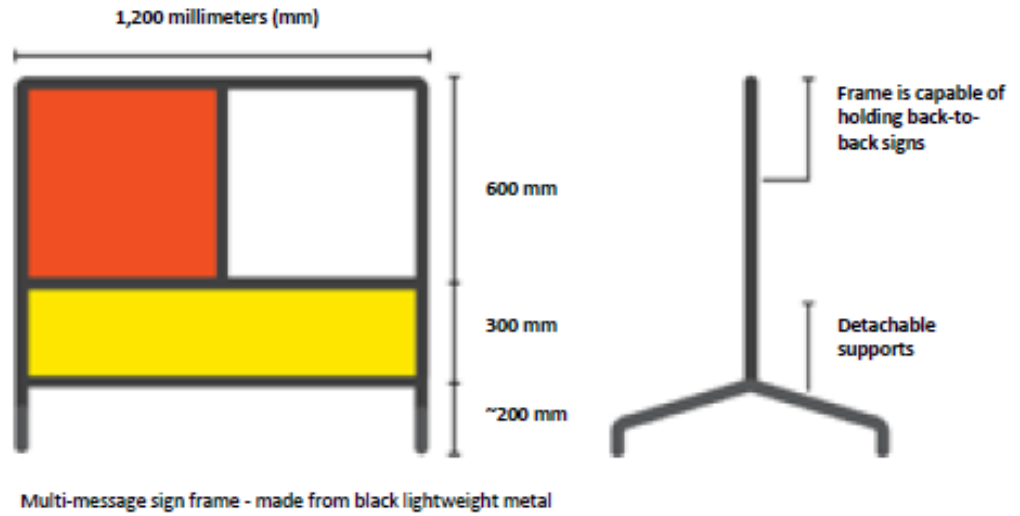
m = meter.

Note: The traffic management plan is for one direction of travel only.

Source: Asian Development Bank.

Multi message signs are useful for road works. Lightweight. Quick to change. Consider these.

Figure 10: Modular Multimessage Frame



Multi-message sign frame - made from black lightweight metal

Source: Asian Development Bank.


40
PREPARE TO STOP


Heads of Camberwell
9882 7600
MG TRAFFIC
ON SIDE ROAD

INSTRUCTIONS FOR TRAFFIC CONTROLLERS

A Traffic Controller is the person on a work site who is responsible for the safety of traffic and pedestrians to pass through the work site safely (and with minimal delay).

The Traffic Controller sets up the TMP zones also.

Instructions for Traffic Controllers


STOP

Road signs

Signs at road work sites should comply with the 6C’s of good signage.

Road safety on rural roads

CAREC

Central Asia Regional Economic Cooperation Program

There are many different types of rural roads

- Expressways
- Highways
- Secondary roads
- Tourist roads
- Farm accesses

And there are many different rural road environments

- Flat
- Undulating
- Hilly
- Mountainous
- Desert
- Coastal
- Jungle
- Farmland

- Divided/undivided roads
- Different speed environments
- Existing roads, rehabilitation and duplication projects, and new road projects


KAZAKHSTAN


TAJIKISTAN


ERITREA


JORDAN


PNG


LAOS
Ntoos Xyooj
27
2018


KAZAKHSTAN


GEORGIA

Consistency is a key message!

Rural roads may have poor safety records – often due to high speeds coupled with poor maintenance.

How can I cover “safety” for so many different rural roads?

There are 8 safety issues that tend to be common on most of the rural roads I have worked on.

Consistency (no surprises)

Better to provide 3-star consistency along an entire route, than 5-star mixed with 1-star sections!

Always think of your “customers”.

Safety on rural roads

- Cross sections
- Alignments
- U-turns on divided highways
- Speed management
- Delineation
- Bridges
- Roadside hazards
- Villages, pedestrians, bus stops

Message 1 – keep cross sections as consistent as possible, and provide wide *paved* shoulders

- Shoulders should be 1.5m and *paved.*
- Some people say paved shoulders encourage “rash overtaking”. (Police enforcement can address this)
- Some people say pedestrians must be provided with an off-road footpath. (Great but not always possible)

A donor funded international highway, with operating speeds around 100kmh, 2.5m shoulders of which only 0.5m is paved. Why?


SIGNATURE
MILD
Rp15,000
Arona
BOLD
Rp10,000
Rp1,000

Safety on rural roads

- Cross sections
- Alignments
- U-turns on divided highways
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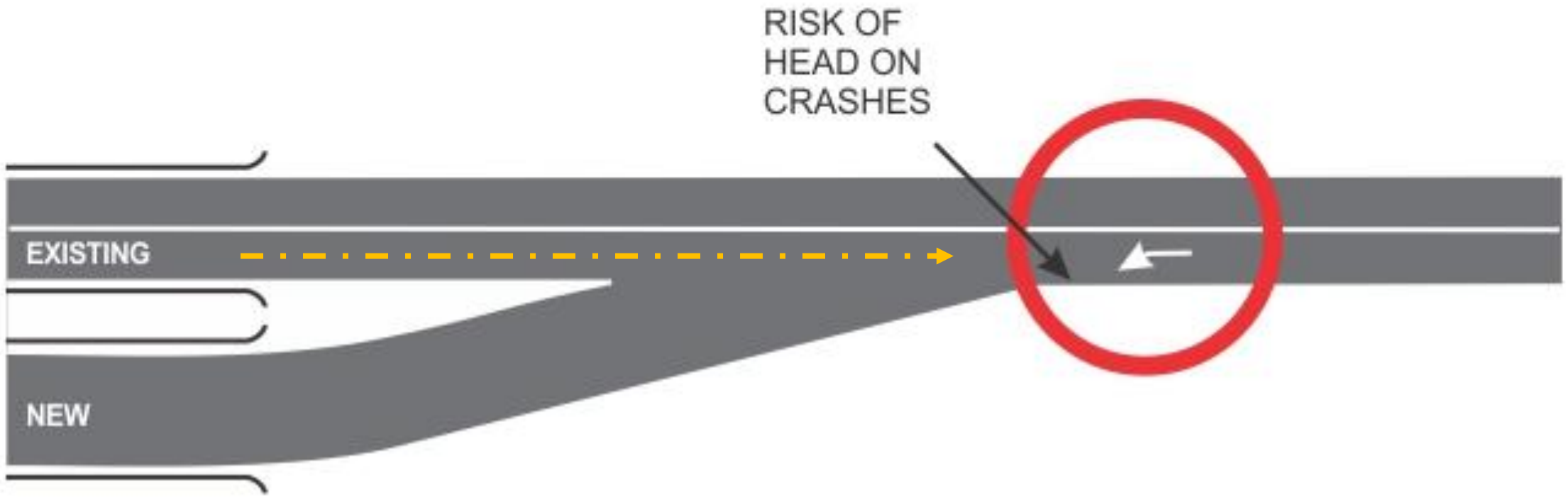
Message 2 – keep H and V alignments as consistent as possible, and watch intersection layouts

- Topography and existing road reserve will impose constraints
- Think about the design speed adopted – if it is too low compared with the practical operating speeds then crash risk will increase. Especially where long straights occur.
- Look at all the intersections along the route.
- No Y-junctions!
- Look carefully at locations where medians end.


RISK OF
HEAD ON
CRASHES
EXISTING
NEW

Where a divided section ends, drop one lane (the slow lane) well before the median ends. Bring traffic back into a single lane, using signs and lines, before the undivided section.

Where a divided section ends, drop one lane (the slow lane) well before the median ends. Bring traffic back into a single lane, using signs and lines, before the undivided section.

RECOMMENDED

An acute Y-junction

A REAL PHOTOGRAPH

ALL SIDE DRIVING!!

Y-junctions are dangerous and must be eliminated from our roads


© 2020 Google
Google Earth

Safety on rural roads

- Cross sections
- Alignments
- U-turns on divided highways
- Speed management
- Delineation
- Bridges
- Roadside hazards
- Villages, pedestrians, bus stops

Message 3 – all medians need to be wide enough to provide sheltered turn lanes

- The existing road reserve will impose constraints – there is generally a reluctance to take more land.
- A narrow median (say 1m) will block turns, intersections and U-turns. It may assist as a pedestrian refuge. But it will not be sufficient for signs or lighting. It will increase rear-end collision risk at openings as turns will be made from the “high speed” lane.
- Keep intersections open along the route – except if there will be sight restrictions. Blocking too many intersections with a median, and sending all side road traffic to new U-turns, is fraught with difficulties. Wrong way movements!
- Look carefully at locations where the median ends.

Provide sheltered turn lanes – essential on high-speed roads

- These reduce risk of rear end collisions
- Gives safe storage area
- Need a median that is at least 4m+ wide (prefer more)
- Needs sufficient length

High-risk median opening

High-risk median opening

Low risk sheltered turn lane (if maintained and used correctly)

Safety on rural roads

- Cross sections
- Alignments
- U-turns on divided highways
- Speed management
- Delineation
- Bridges
- Roadside hazards
- Villages, pedestrians, bus stops

Message 4 Gain driver/rider trust. Use regulatory speed restriction signs consistently but NOT for individual curves, crossings, bridges or other locations

- Gain driver respect for the speed management regime in your country.
- Can you rely on drivers to know the speed limit – 90 rural, 60 urban?
- I don't – so apply signs consistently, and in pairs.
- Maybe 100kmh, or 80kmh on rural roads, 40kmh or less in villages.
- Ensure all hazards and crossings and bridges are adequately signed with warning signs and good delineation.
- Do NOT use regulatory signs for a "warning" – it brings them into disrepute.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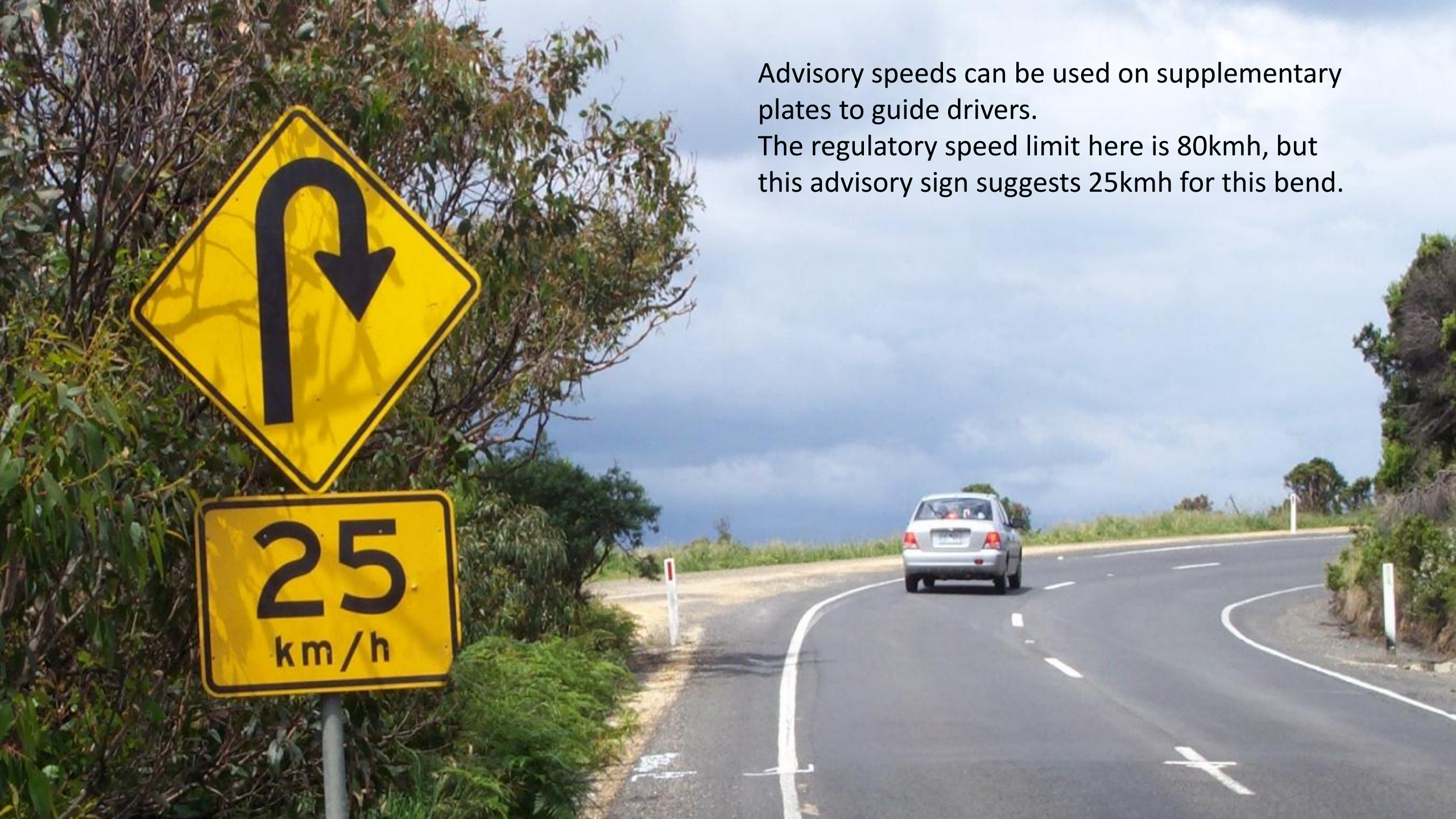
30
NESCAFÉ



Advisory speeds can be used on supplementary plates to guide drivers.
The regulatory speed limit here is 80kmh, but this advisory sign suggests 25kmh for this bend.

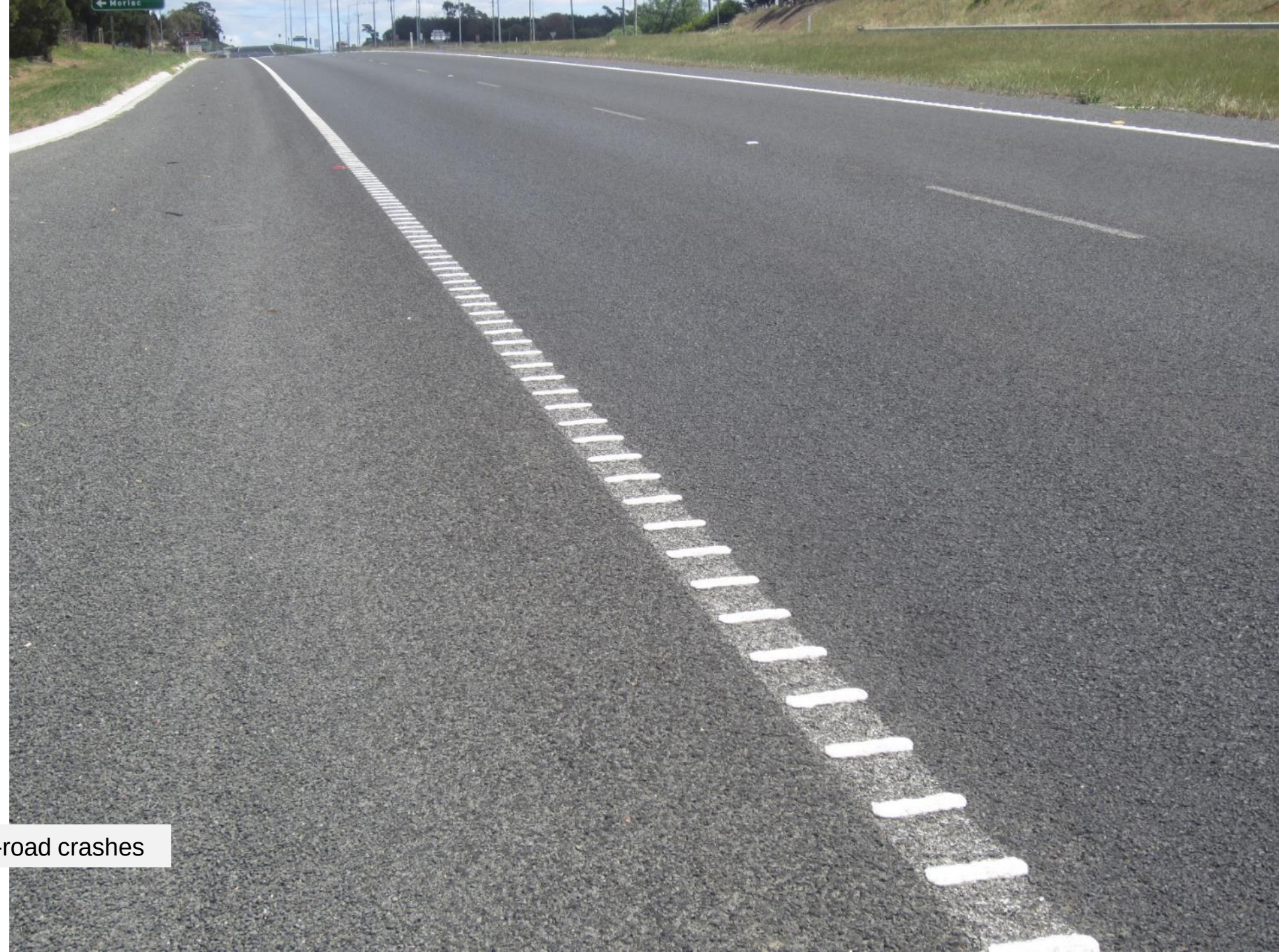
Safety on rural roads

- Cross sections
- Alignments
- U-turns on divided highways
- Speed management
- Delineation
- Bridges
- Roadside hazards
- Villages, pedestrians, bus stops

Message 5 Delineation is essential – and best when it is consistently applied along a route

- Better to have 3-star delineation consistently, than a mix of 1-star and 5-star sections.
- Think of theft, vandalism, natural damage.
- Discuss and decide if it is better to use more robust (but less forgiving) devices in your country. How many m/c do you have?
- Some countries have many pedestrians and small vehicles in rural areas; some have very few.


OK for delineation but
unsafe for motorcyclists!



50% CRF for run-off-road crashes

Safety on rural roads

- Cross sections
- Alignments
- U-turns on divided highways
- Speed management
- Delineation
- Bridges
- Roadside hazards
- Villages, pedestrians, bus stops

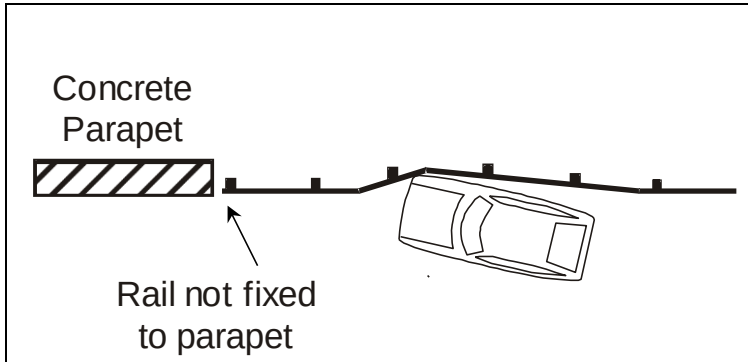
Message 6 Bridges should be “just another part of the road”

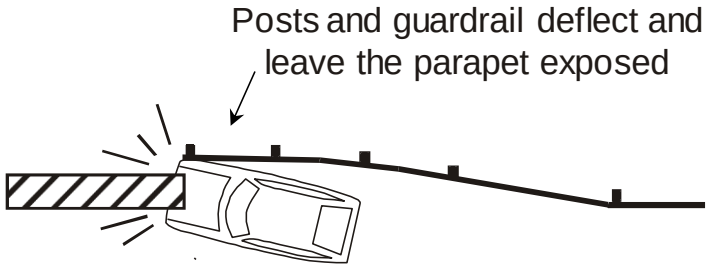
- Bridges are more expensive than other sections of road.
- Engineers try to save $$ by making them as narrow as possible.
- But at what crash cost?
- How will pedestrians and small vehicles safely cross the bridge?
- We don’t want the bridge to be a “squeeze point” for pedestrians, two and three wheelers, or animals.

Message 6 Take the full shoulder width across new bridges, and provide a protected/separate bridge for pedestrians

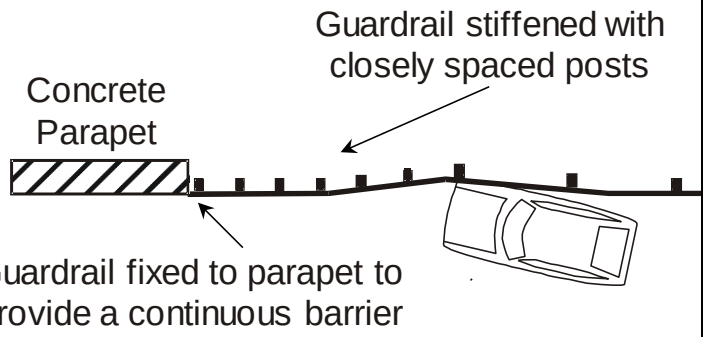
- Take a full width shoulder across every new bridge.
- Install adequate safety barrier on all four parapets and secure it.
- Install reflective Width Markers to highlight the bridge parapets.
- Explore ways to help pedestrian/ small vehicle safety.
- Is a raised “footpath” safer than nothing? How wide should it be? How will m/c access it?

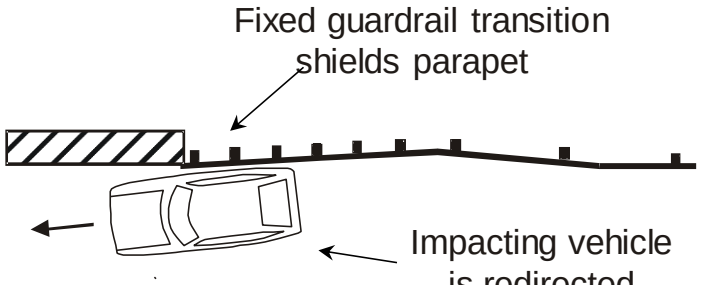

The shoulder has
“disappeared” at the bridge
Be alert for this in
design drawings





Performance without guardrail / bridge barrier connection





Performance with guardrail / bridge barrier connection

Where has the shoulder gone?

Why have raised footpaths on the bridge – but none either side of the bridge?

These 3-wheelers are not able to stay out of traffic

Bridges must safely serve all “customers”

In such cases, pave the shoulders – at least 200m approaching the bridge.

Then hatch out the final 50m with bold white hatching to alert riders of the hazard ahead. And also construct a ramp onto the raised path.

Bridges must safely serve all “customers”


This is a “standard” design in Georgia – but it is unsafe.
Prevention is better than cure

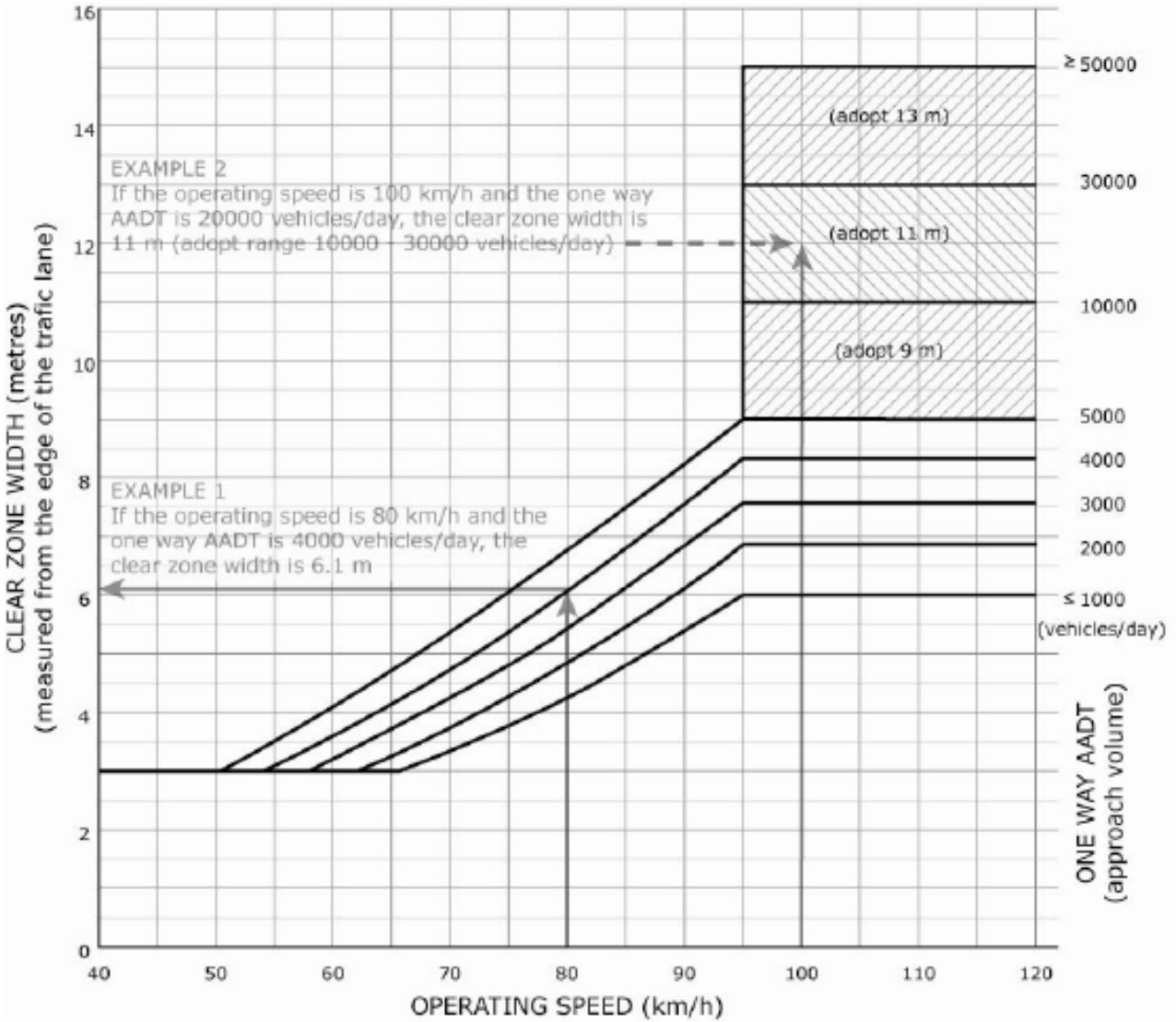
This “standard” design is highly unsafe.

Safety on rural roads

- Cross sections
- Alignments
- U-turns on divided highways
- Speed management
- Delineation
- Bridges
- Roadside hazards
- Villages, pedestrians, bus stops

Clear Zone Chart

Figure V4.1: Basic Clear Zone Widths on Straights – All Roads

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Use the Roadside Hazard Management strategy

1. **Keep vehicles on the road**
2. **Provide a forgiving roadside**

2 i. remove the hazard

2 ii. relocate the hazard

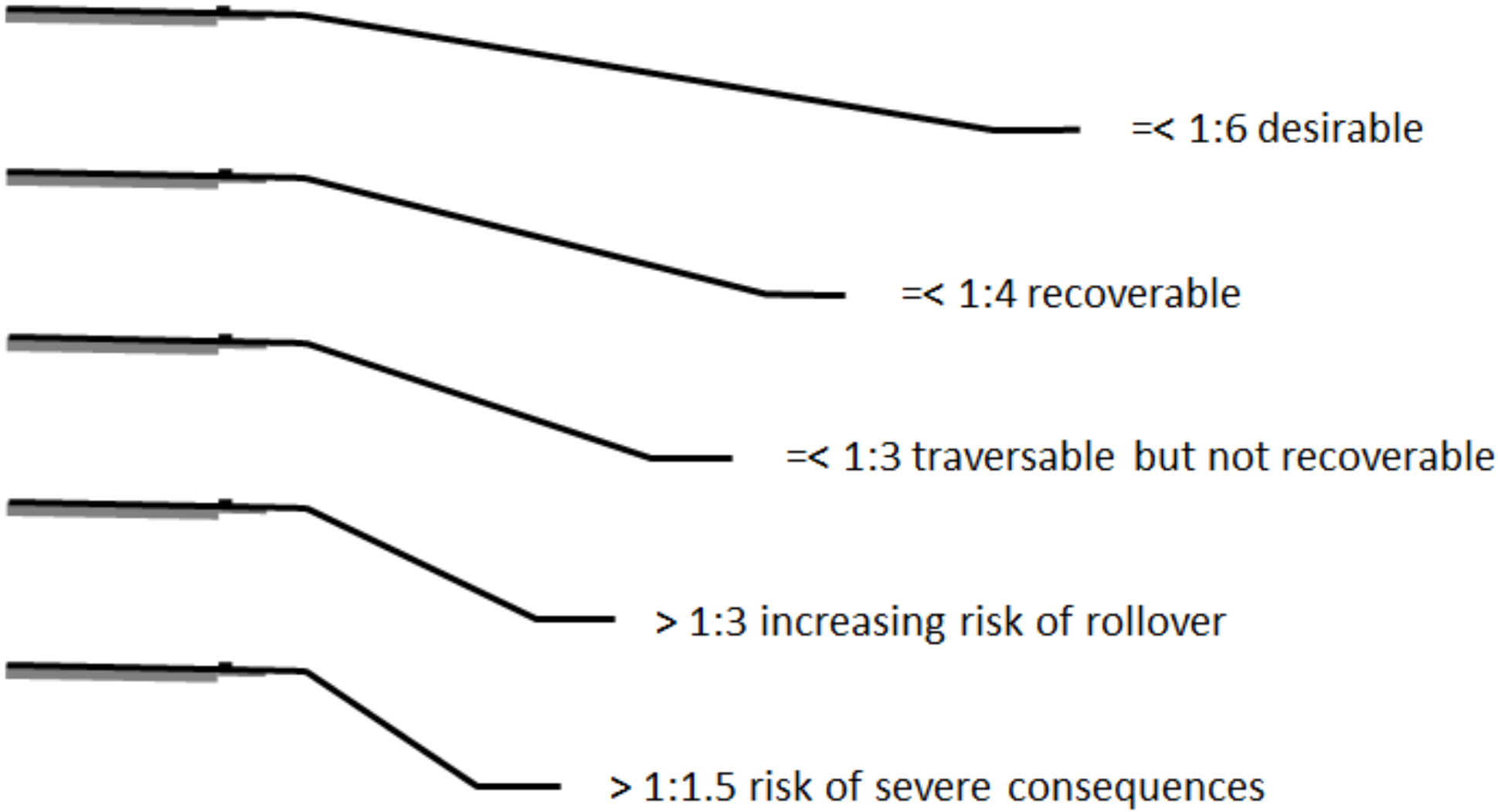
2 iii. alter the hazard to reduce severity

2 iv. protect the people with barriers


SCANIA

Remember – an auditor tries to foresee such crashes while the road is still in the design stage

Prevention is better than cure


=< 1:6 desirable
=< 1:4 recoverable
=< 1:3 traversable but not recoverable
> 1:3 increasing risk of rollover
> 1:1.5 risk of severe consequences

Safety on rural roads

- Cross sections
- Alignments
- U-turns on divided highways
- Speed management
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Message 8 Traffic calm villages

- Gateway treatments should become “standard”.
- Decide a suitable speed limit for the village and post adequate signs.
- Ask - will it be enforced by Police?
- If not – what are your options – road humps work best, followed by roundabouts and chicanes and raised junctions.
- *DO NOT* accept that the villagers must “pay the price” when a rural road is rehabilitated.

Visual impacts due to line marking

“Gateway”


BANRAEABA
40
How Fast Are You Driving?
BANRAEABA
40
Iraua Ngkai Butim?

Vertical displacement


Vertical displacement


WOULD YOU INSTALL ROAD HUMPS, OR HUMPED PEDESTRIAN CROSSINGS ON THIS NEWLY CONSTUCTED ROAD?

One good safety initiative on the Dushanbe-Turzunade Road – a median, without barrier, serving as a pedestrian refuge in one large town!

Pedestrians are legitimate users of rural roads

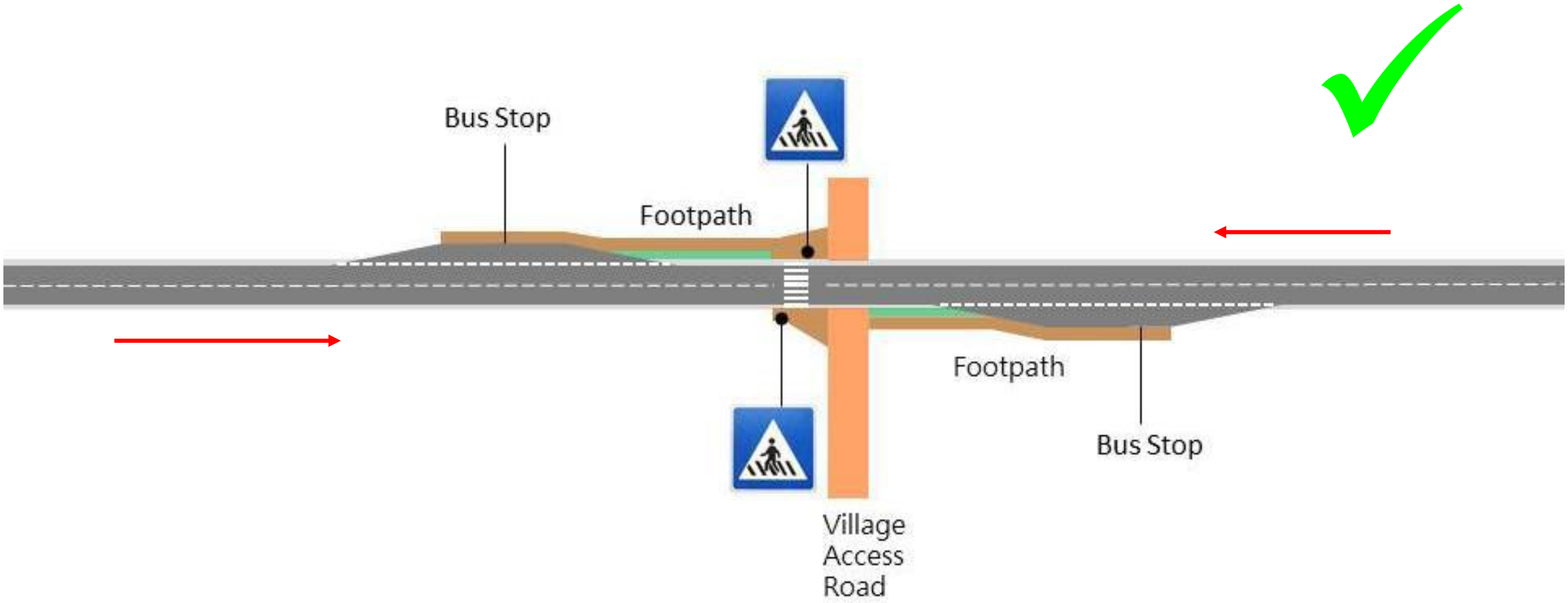
- They walk on/beside most rural roads in most countries - day and night
- If we cannot offer an “off-road” path, then we must offer wide paved shoulders.
- There should be no squeeze points (culverts, or bridges) as they walk along a road.
- Do NOT use Zebra Crossings (or signals) in rural areas.
- They do not command driver respect in high-speed areas.
- Warning signs, good sight lines, medians and lighting are better options.


Real life!


Do NOT place Zebra Crossings in high speed areas, or over multi-laned roads
International highway, in a rural area, speeds around 110kmh

Best to have a paved stopping area off the road, and best NOT to place Zebra Crossings in high speed areas, or over multi-laned roads

Best to NOT place Zebra Crossings in high speed areas, or over multi-laned roads



Driving on right side. With this configuration, a stopped bus will not obscure sight lines to/from a pedestrian on the crossing. But still, do not place a Zebra crossing in high-speed zones!

Most important messages from this workshop

Engineers *<u>are</u>* important in road safety.

Put the ***<u>ROAD</u>*** into road safety!

<u>YOU</u> can save lives - design, build, manage safer roads.

- Fix blackspots
- Use audits to ensure new designs will be safe
- Remember pedestrians and roadside hazards

Treat road safety as a business.

Look and plan “long term”

This is a big challenge in *all* countries

- TREAT ROAD SAFETY AS A BUSINESS

Then ask what can you do – effectively - at low cost?
Blackspot investigations and treatments
Road safety audits – change while still a “mouse click on the computer”.
Pedestrian facilities – kerb extensions, ped refuges. NOT only overpasses!

Some may say – not enough $$$$$

There was enough money to build this overpass!

You can see that it gets little use.

“Road safety” doesn’t happen overnight

In 1970 - Victoria had fatality rates higher (>30) than your rate today.

Since then, my state has achieved world class rates. Your country can too.

It takes:

- Time.
- Co-operation with stakeholders.
- Resources.
- Some champions (like some of you)

You can save lives

- Put yourself into the shoes of your “customers” – the road users.
- You can make your roads safer for all.
- The world needs more road safety engineers.
- I wish you well in your careers.

Thank you.
Your questions are welcome

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