

Welcome to the CAREC
“Road Safety Engineering”
Workshop

- for professionals in Turkmenistan

Module 2 Roadside hazard management

Thursday 14th April 2022



Welcome back to you all



Successful
completion
of this
workshop
requires

- Participation in all six modules
- Attempted answers to the Poll Quiz questions
- Satisfactory preparation of a hazardous road location report with recommended treatments
- Satisfactory completion of a road safety audit report, with recommended treatments.



Objectives of this session:

-
- to encourage you to work towards safer road infrastructure.
 - to explain roadside hazard management
 - to outline the three groups of safety barriers
 - to provide some guidance about where to use – and not use – safety barriers
 - to show some safety barrier issues



Single vehicle run-off-road crashes

- are the single biggest group of serious and fatal crashes in most countries.
- They are a severe type of crash.
- They can be due to speed, inattention, fatigue, alcohol, poor geometry, inadequate delineation (or all of these).
- We can never be sure where or when a vehicle will leave a road



Check out the CAREC “Roadside Hazard Management” manual

English
Russian
Mongolian
Chinese



Download from the ADB website

What is Roadside Hazard Management ?

Roadside hazard management aims to.....
“identify, prioritise and treat roadside hazards in order to maximise safety by reducing the incidence and/or severity of such crashes.



THE THREE "I's

- IDENTIFY
- INVESTIGATE
- IMPLEMENT



To provide a forgiving roadside environment, we need to ask...

> What is a hazard?

> How far off the road must a hazard be before we can accept it as “safe”?

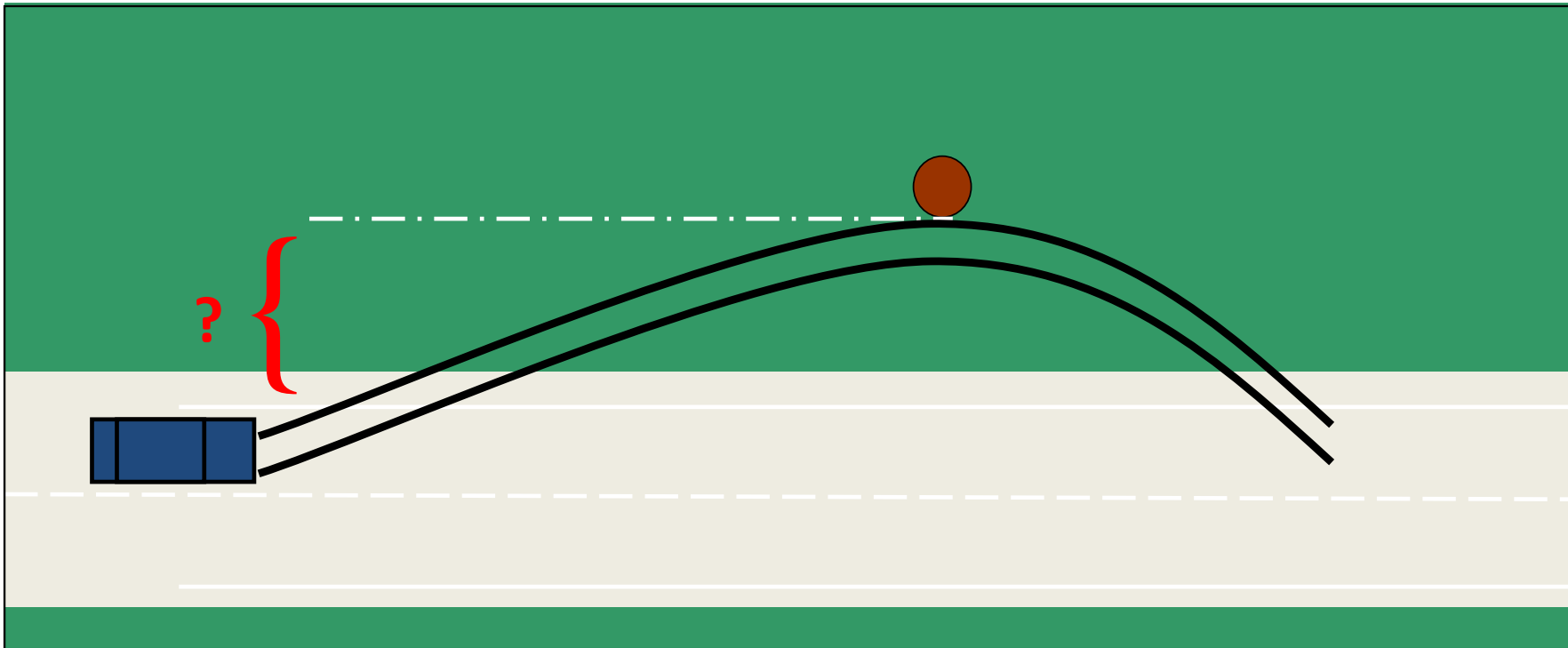
> Is there one width that can be used for all roads?



What is a Clear Zone ?

“A drivable roadside area that should be kept clear of hazardous objects in order to minimise the danger of a collision, should a vehicle leave the road”.

What is a Clear Zone ?



How do we determine the Clear Zone for a road?

A clear zone depends on:

- vehicle speeds
- vehicle volumes
- road curvature
- embankment slope



Figure 1 Clear Zone for Straight Roads

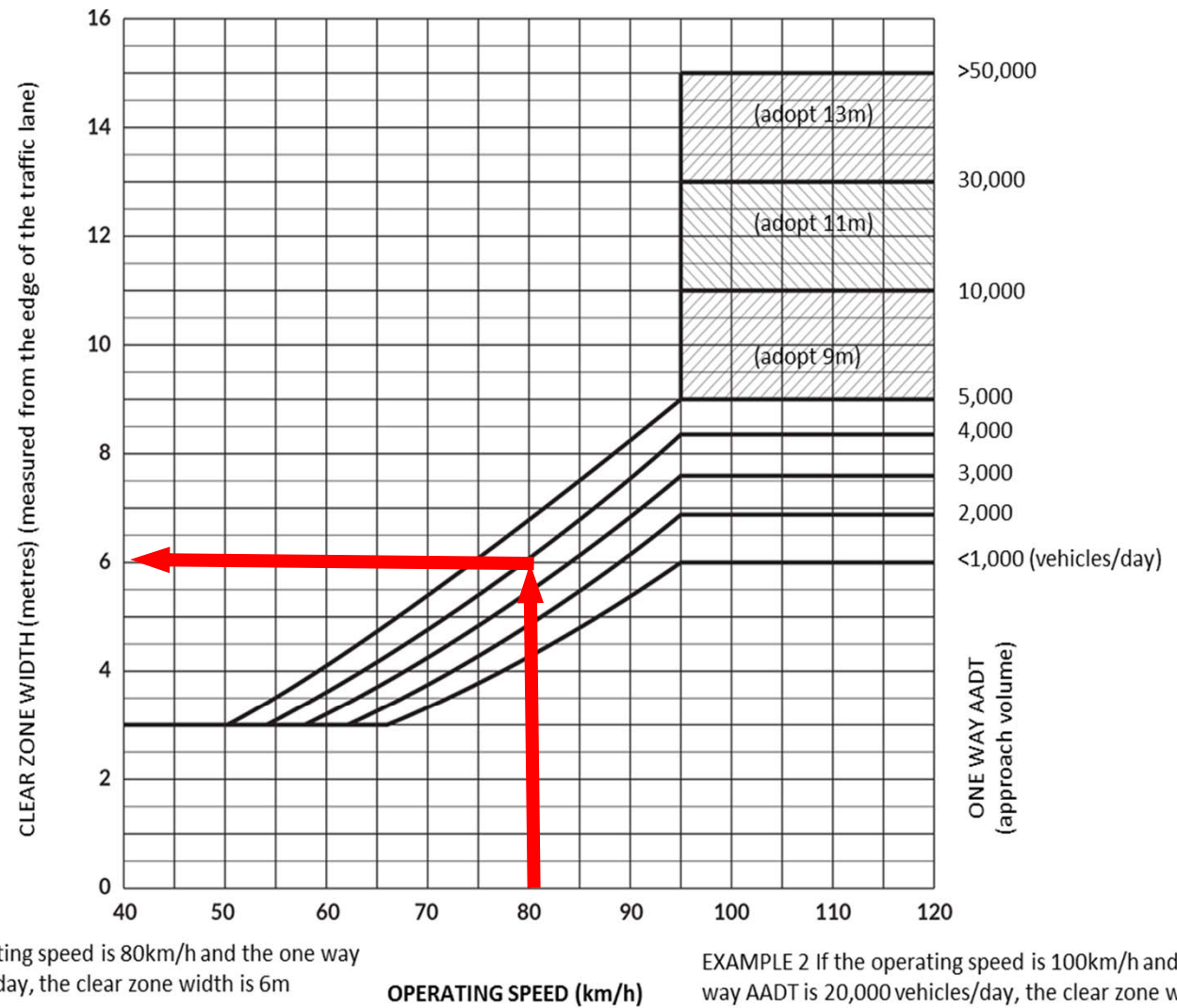
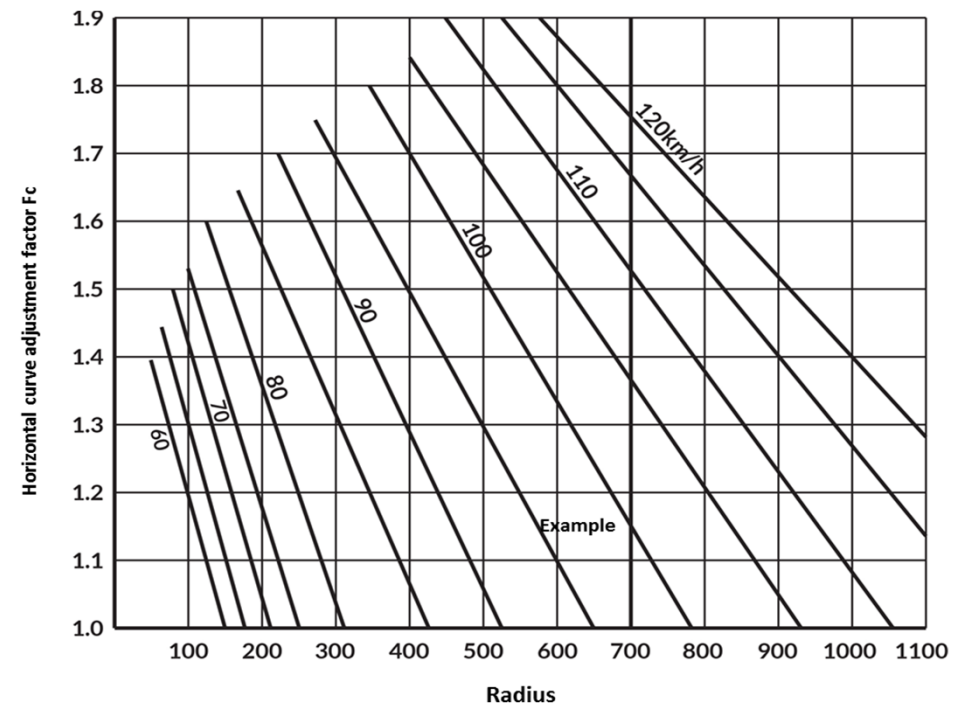
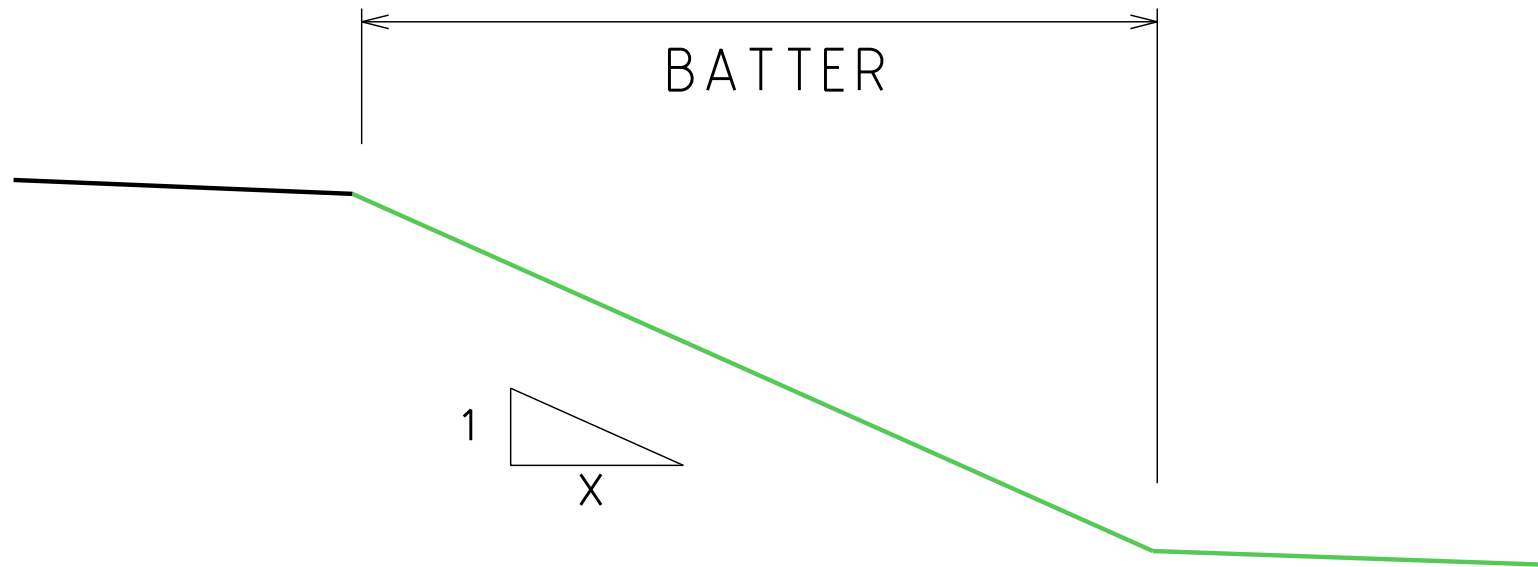


Figure 2 Clear Zone Adjustment Factors for Curves



Note: For Radii > 1,000 metres use $F_c = 1.0$

Example:
On a 700 metre radius curve with an
Operating Speed of 100km/h, the
graph suggests an F_c of 1.15



Maximum Side Slopes

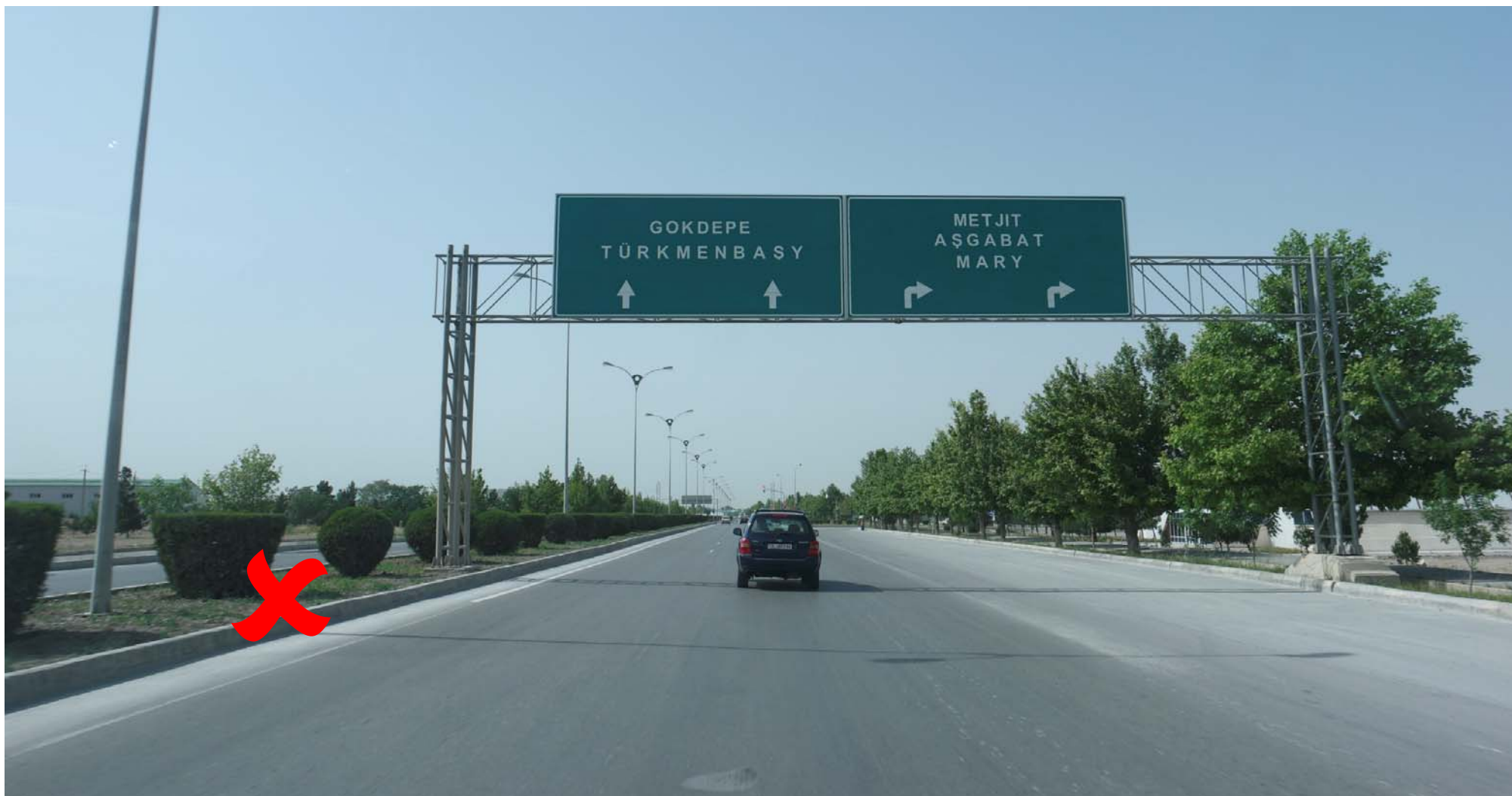
- 6H:1V Drivable limit for trucks
- 4H:1V Drivable limit for cars
- 3H:1V Limit for mowing
- 2H:1V Generally requires planting
- 1.5H:1V Often requires beaching



Anything that is “fixed”, with a diameter of 100mm or more, and is on the roadside, within the clear zone.

So, what is a roadside hazard?





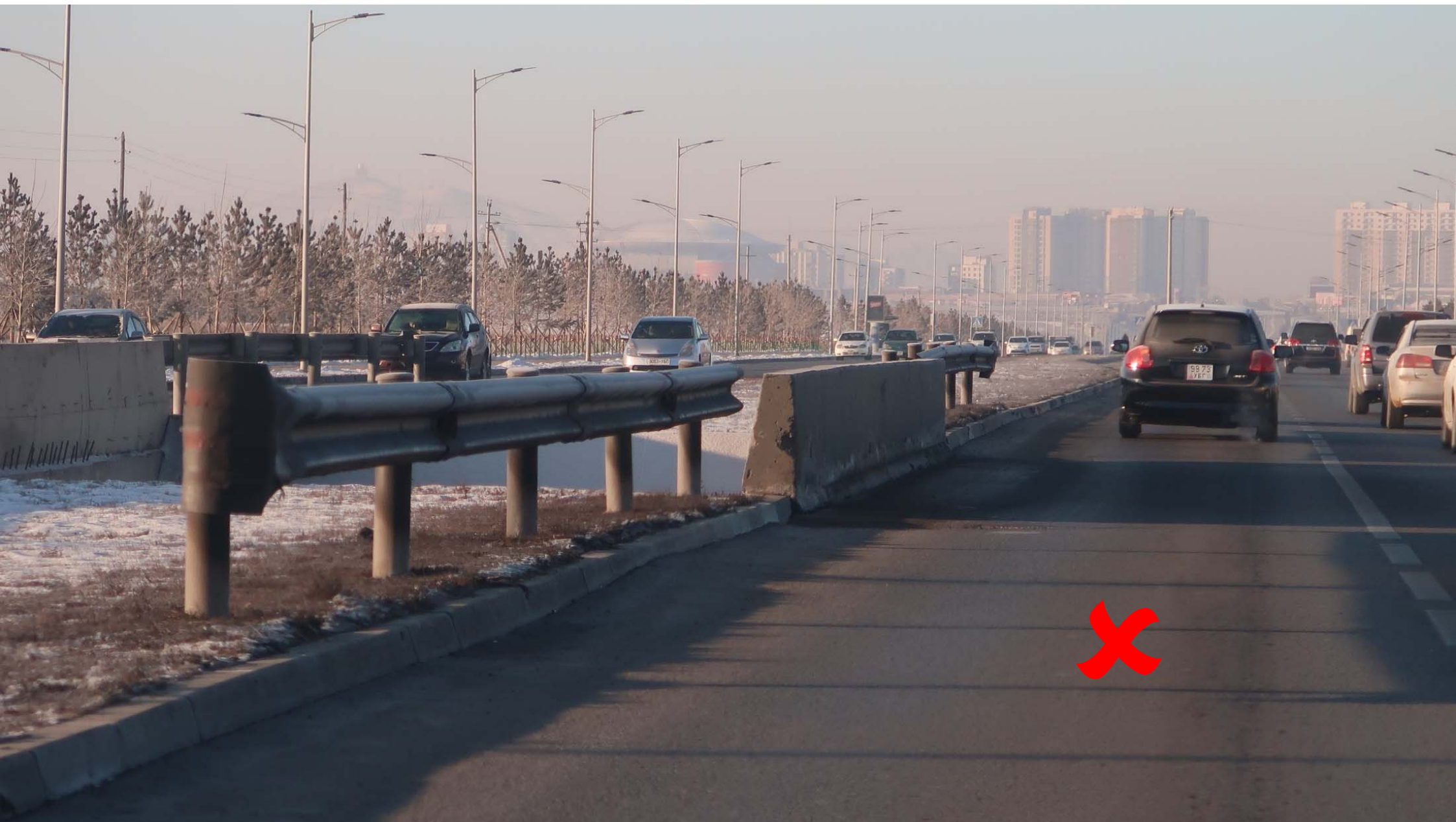








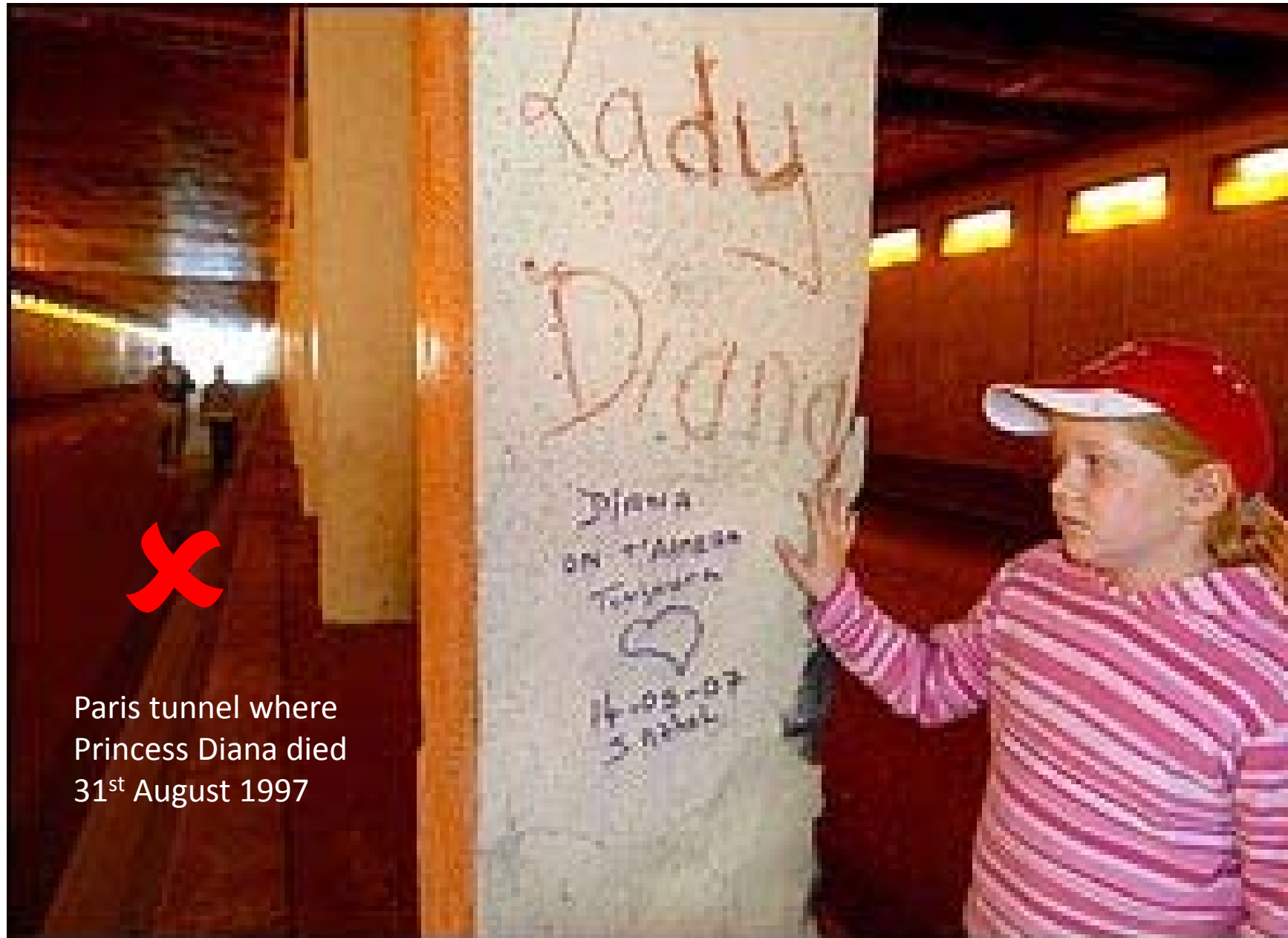












Paris tunnel where
Princess Diana died
31st August 1997





Culverts
are dangerous





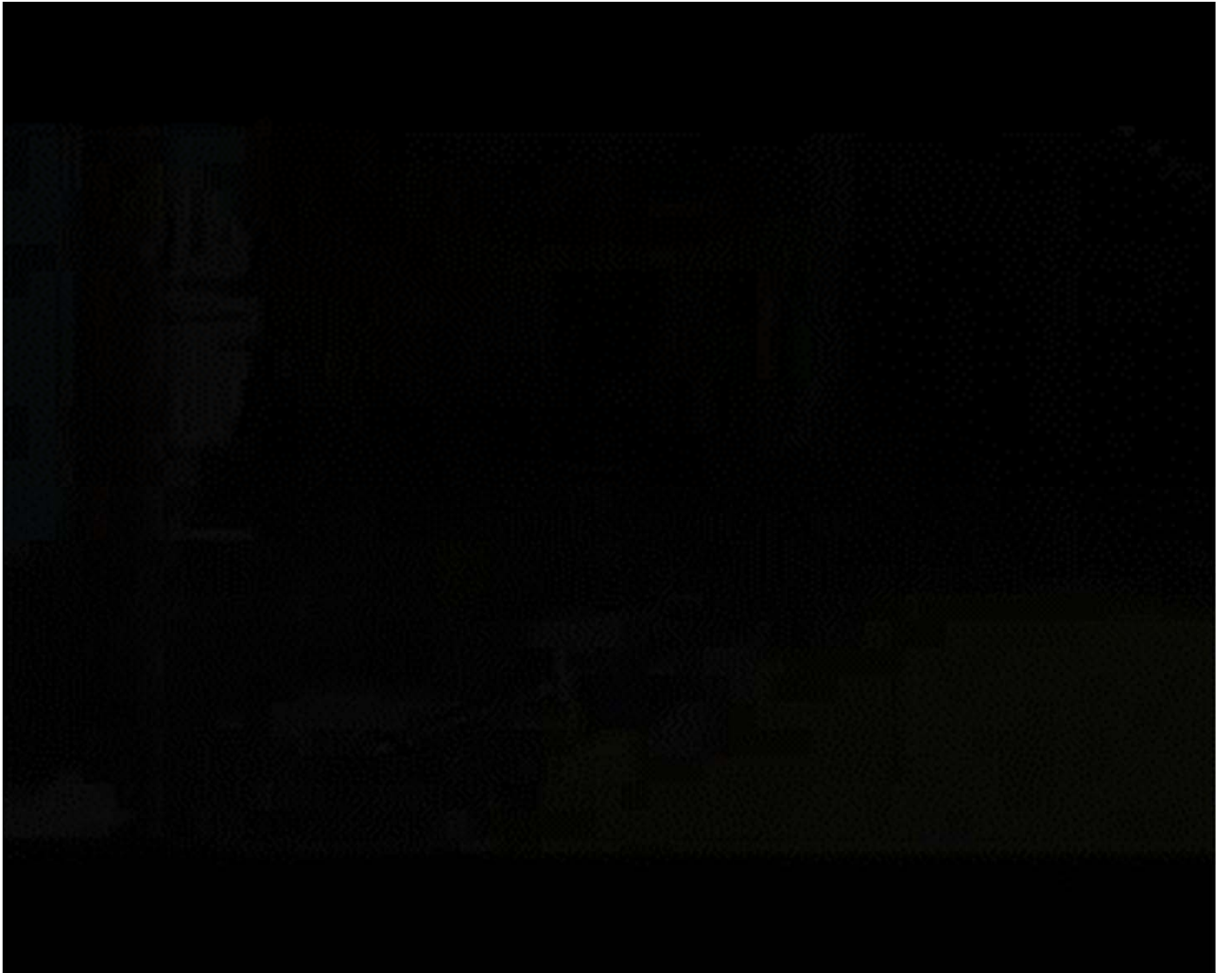
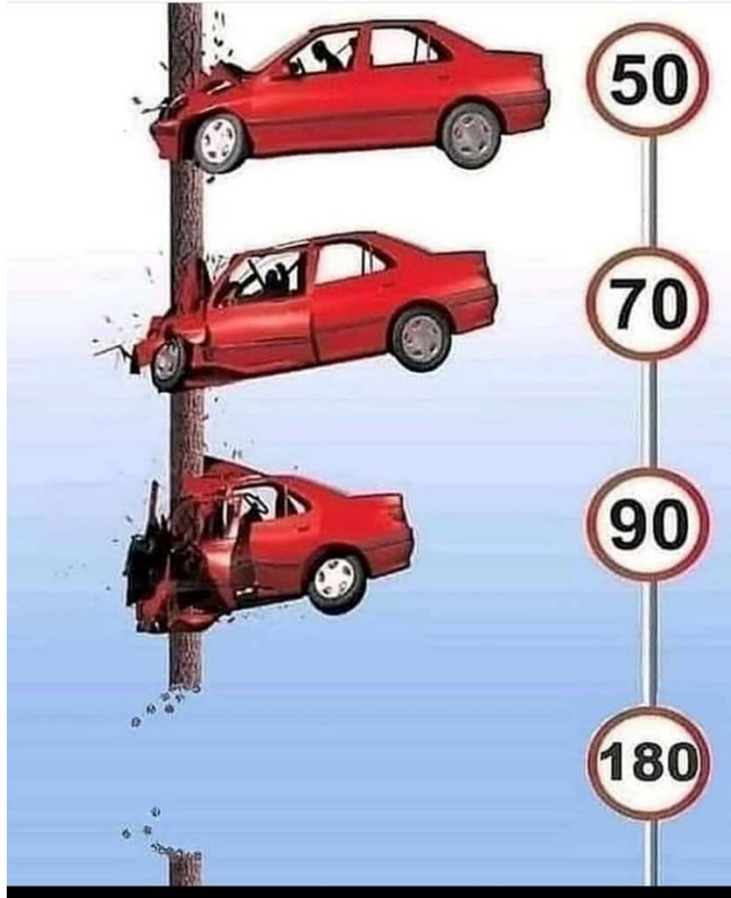






TABLE 1-1 U.S. Motor Vehicle Occupant Fatalities in Crashes in Which Striking a Roadside Object Was the Most Harmful Event, Selected Roadside Objects, 2010–2015

Year	End Terminal	Guardrail	Concrete Barrier	Cable Barrier	Bridge Rail	Impact Attenuator	Sign Support	Utility Pole/Light Support	Tree	All Occupant Fatalities
2010	71	436	154	21	80	11	104	1,019	3,602	27,889
2011	96	402	154	21	78	14	132	913	3,567	27,140
2012	92	407	176	27	61	22	97	1,013	3,687	28,003
2013	104	393	197	21	55	21	118	921	3,616	27,175
2014	110	372	203	17	82	21	127	957	3,508	26,901
2015	99	405	189	34	68	21	117	926	3,605	28,671





The three I's

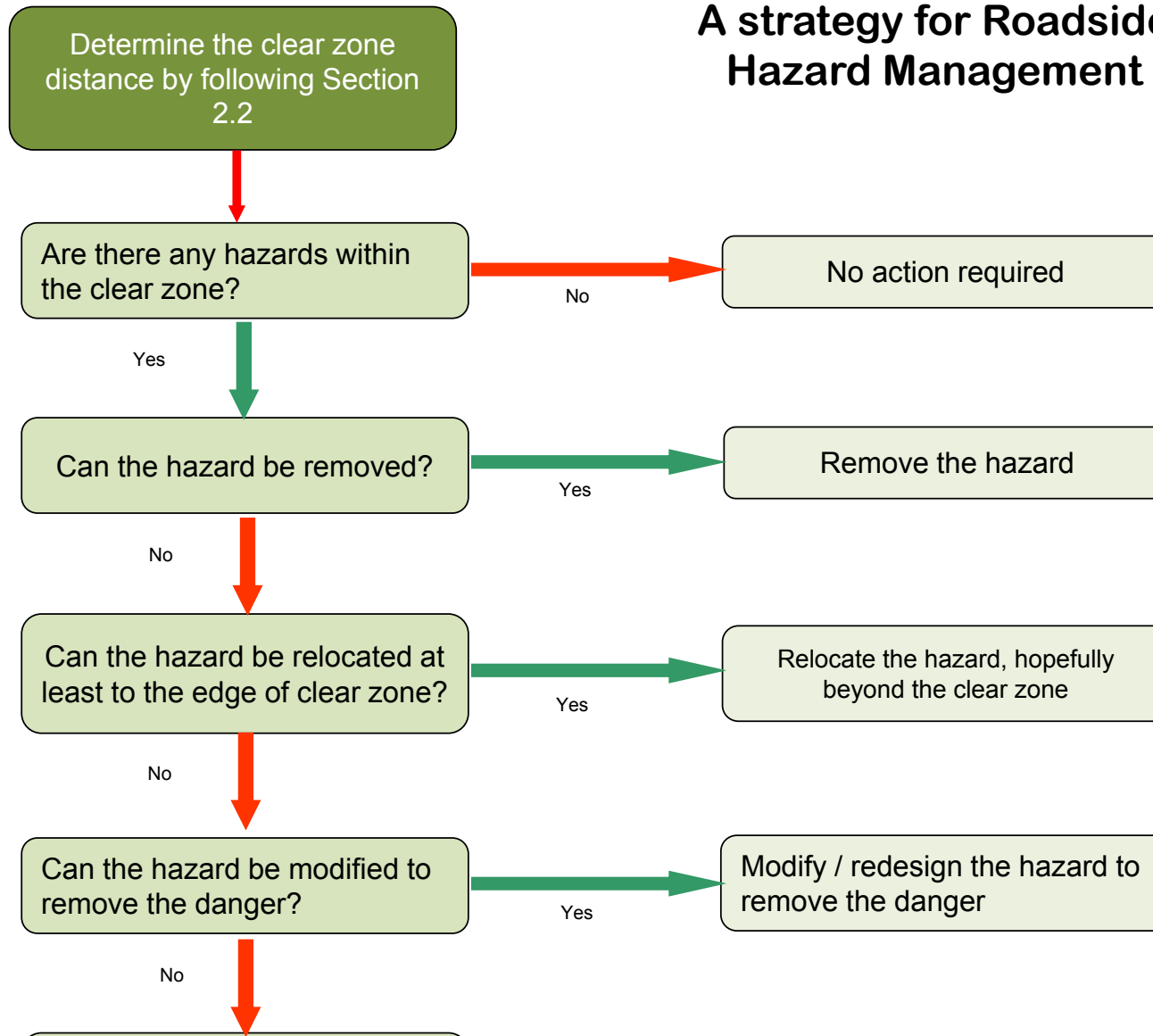
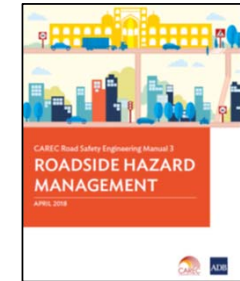
- IDENTIFY
- **INVESTIGATE**
- IMPLEMENT

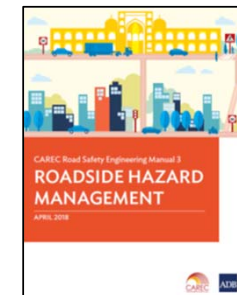
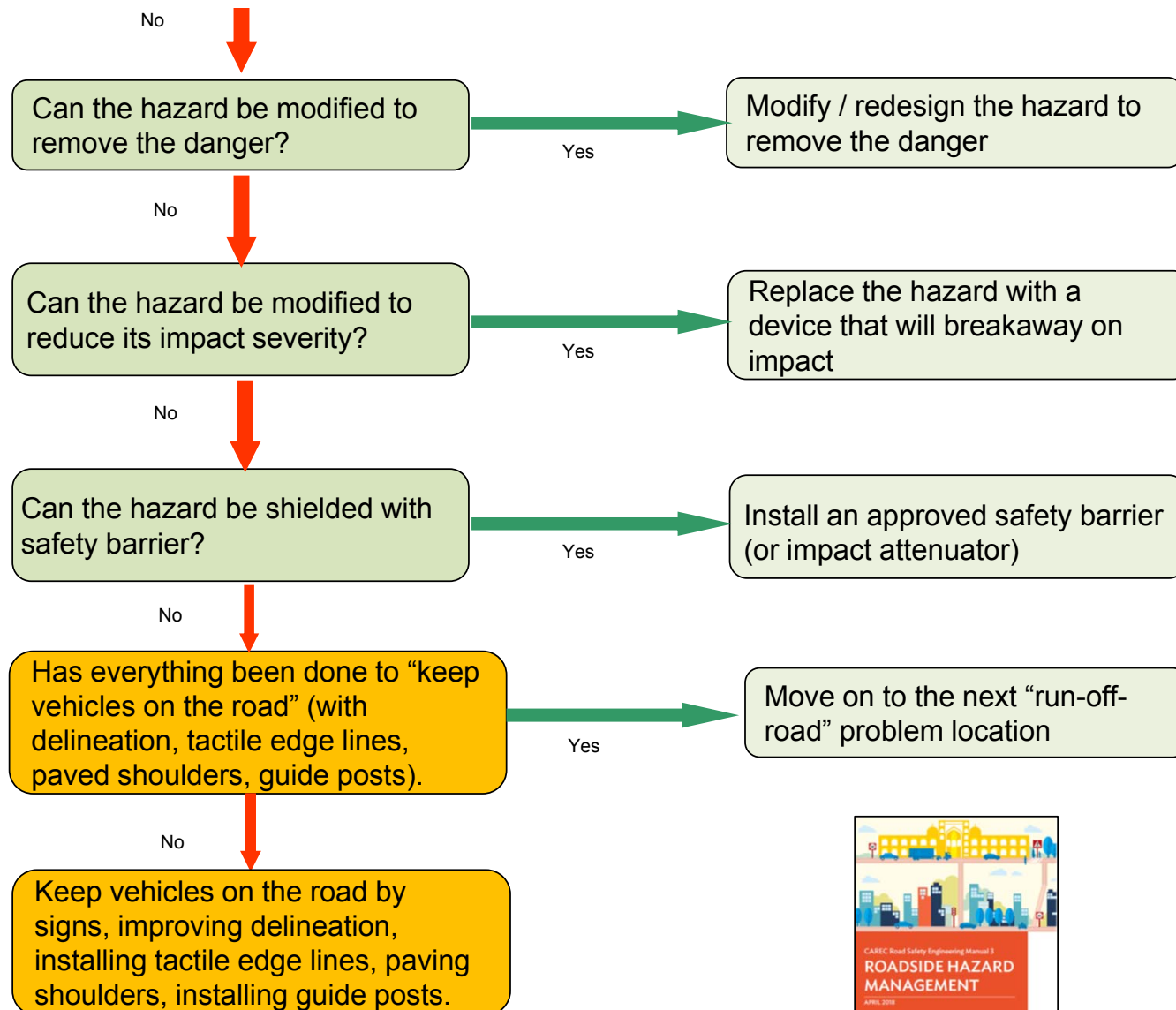
A strategy for Roadside Hazard Management

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

- i. remove the hazard
- ii. relocate the hazard
- iii. alter to reduce severity
- iv. shield the hazard using barriers

A strategy for Roadside Hazard Management





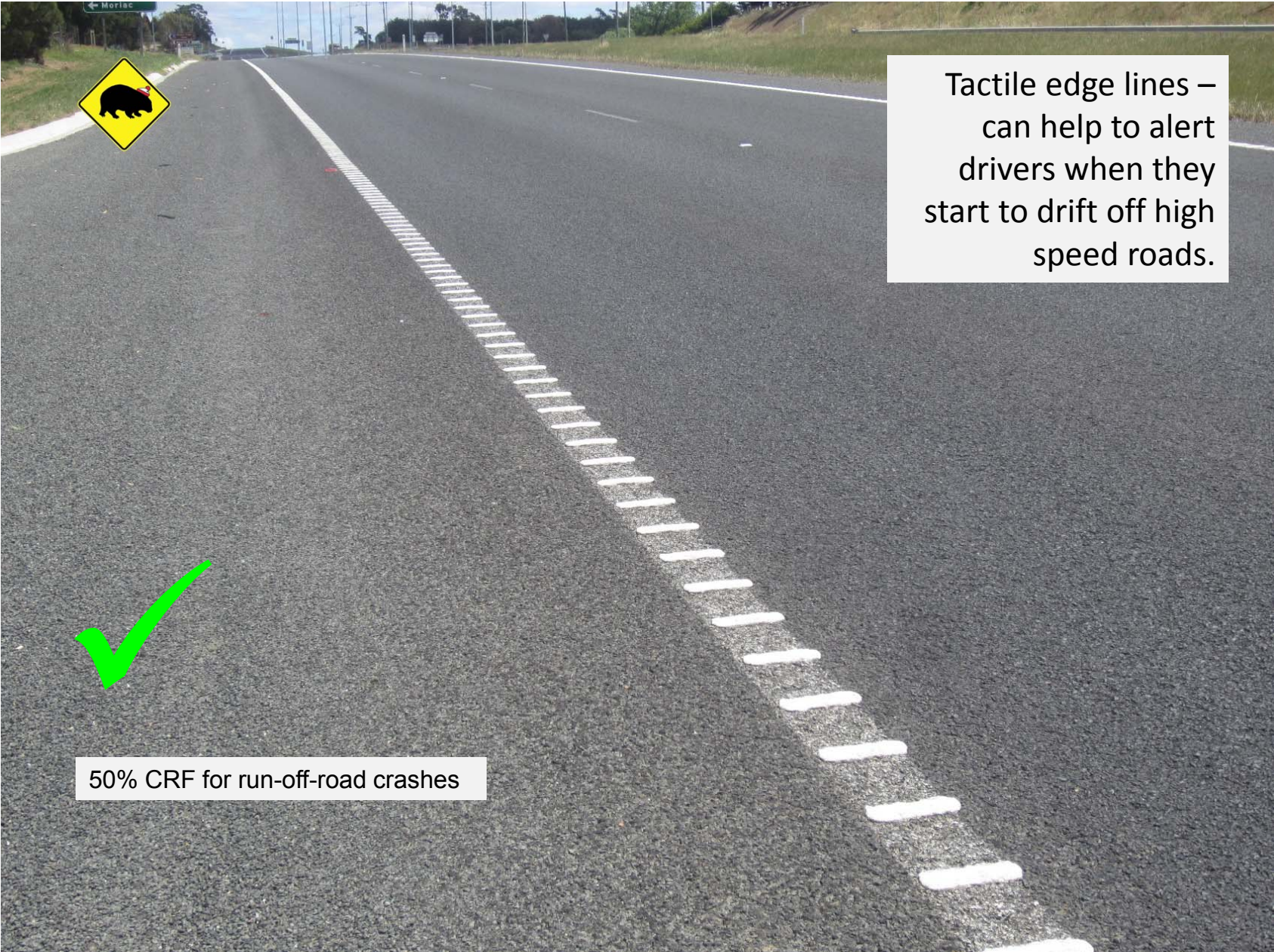
Has everything been done to “keep all vehicles on the road”?

- Improve geometry
- Seal shoulders
- Line marking
- Edge lines (tactile)
- Guideposts
- Chevron alignment markers
- Improve sight lines - cut grass





Good delineation – essential!



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

50% CRF for run-off-road crashes







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

50% CRF for run-off-road crashes




Guideposts are useful – often essential in rural areas!

Remove the Hazard

Remove trees, poles
Place power underground
Combine services onto a single pole
Demolish structures

Relocate the Hazard

Move the hazard to a location outside the clear zone or at least to a less vulnerable position - to reduce risk



Alter the hazard to
reduce
impact severity

- frangible lighting poles
 - slip base
 - impact absorbing
- frangible signposts
- “soften” steep slopes
(4:1 or flatter)
- drivable culverts

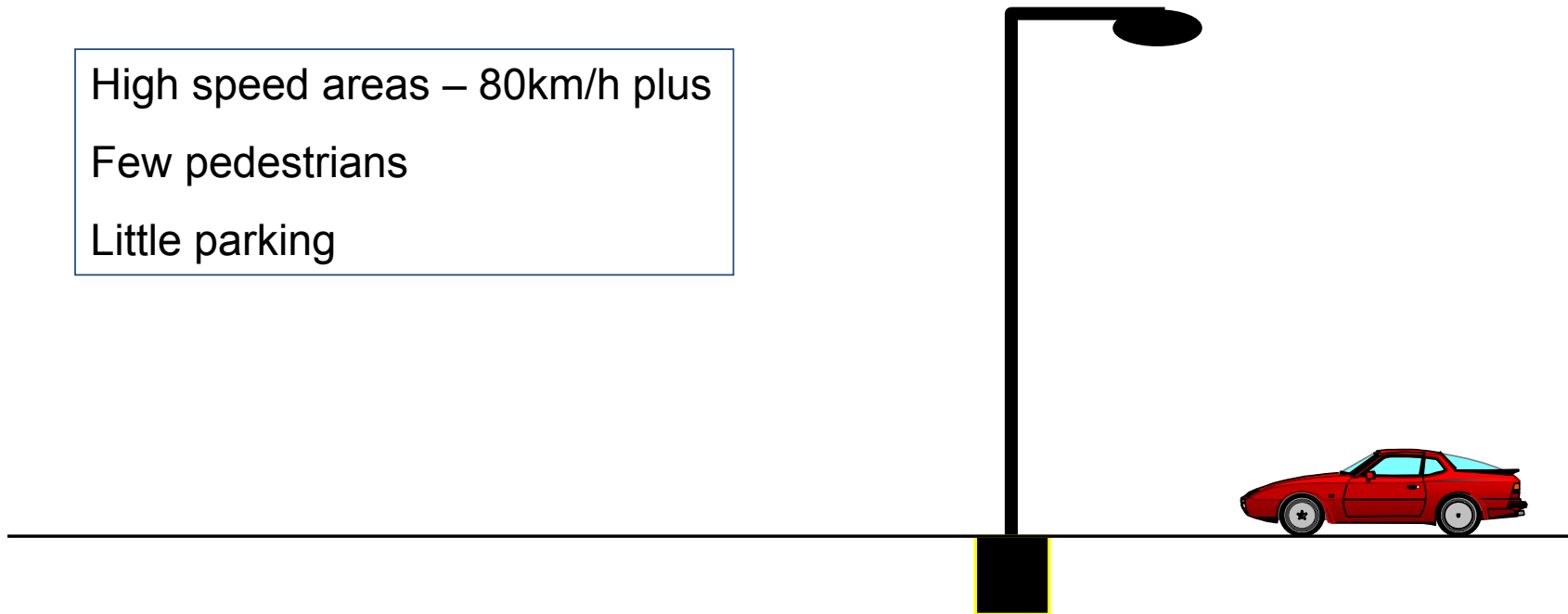


Frangible lighting poles

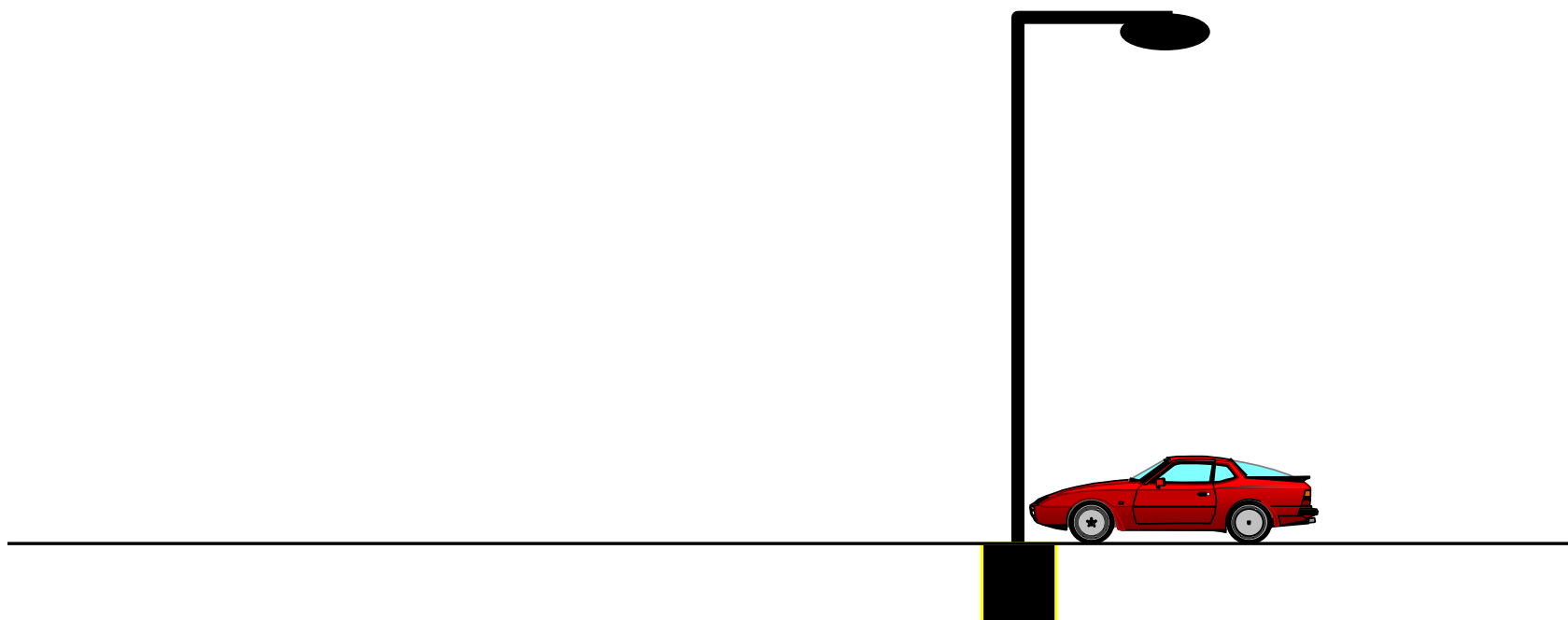
- slip base
 - impact absorbing
-

Slip Base Pole

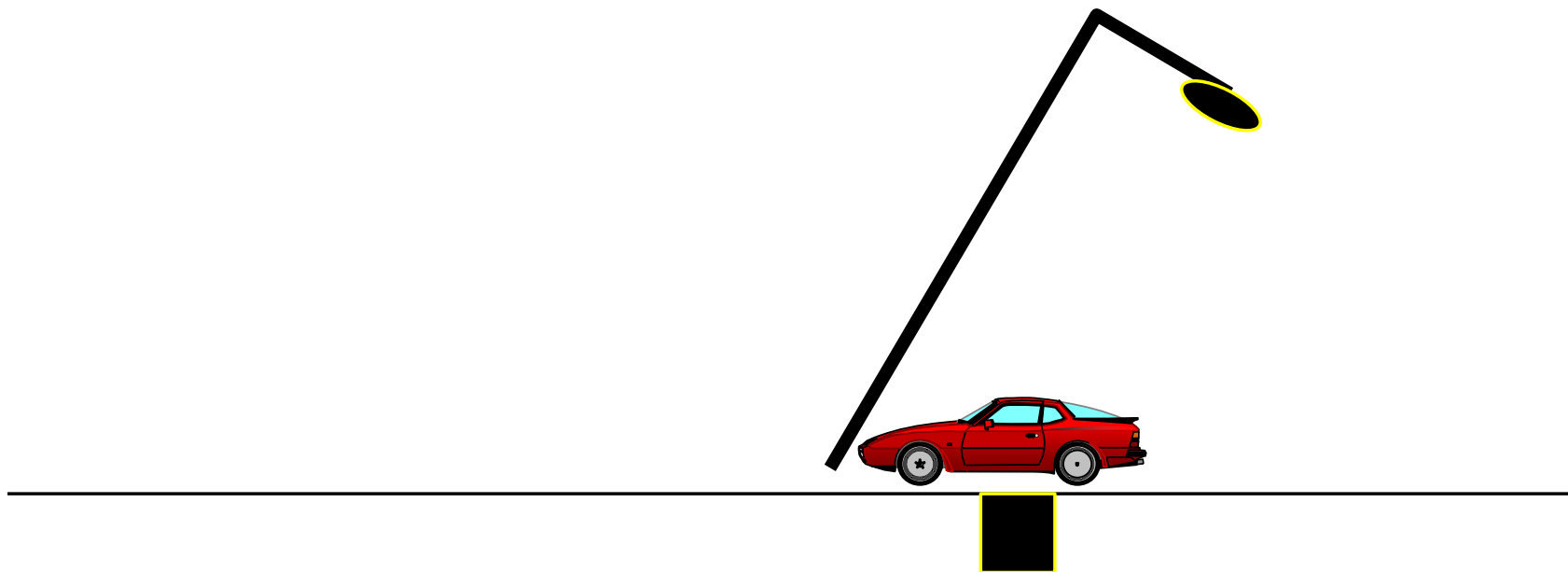
High speed areas – 80km/h plus
Few pedestrians
Little parking



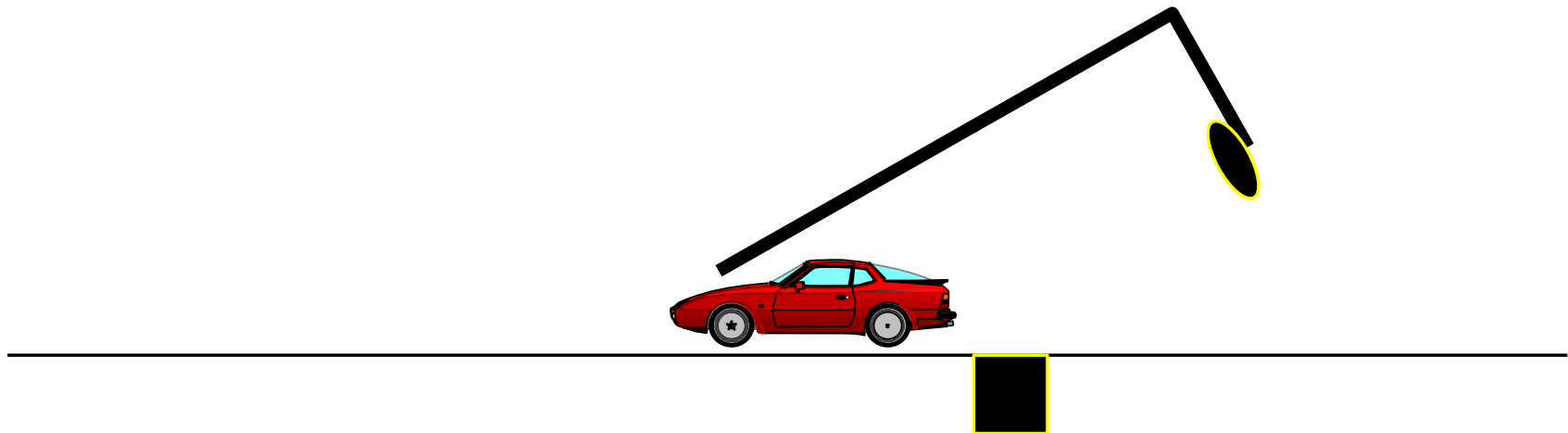
Slip Base Pole



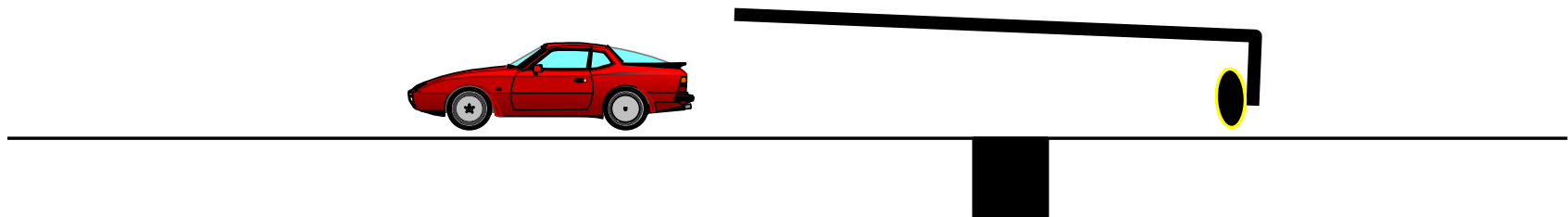
Slip Base Pole



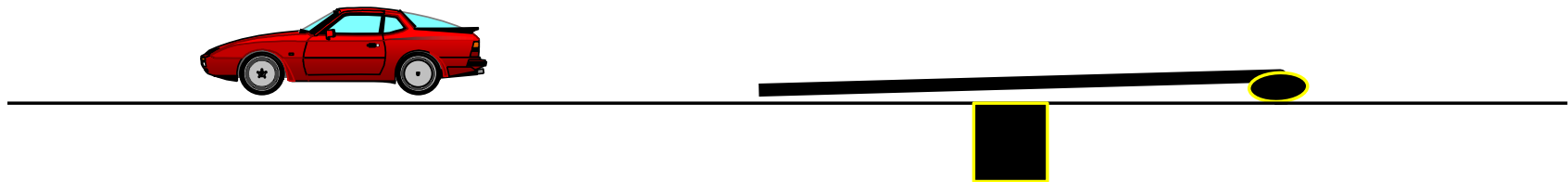
Slip Base Pole



Slip Base Pole



Slip Base Pole



Slip Base Pole

Before impact



Slip Base Pole

After impact



Slip Base Pole



After impact





Slip base columns MUST be able to slip
when struck. DO NOT concrete them in!

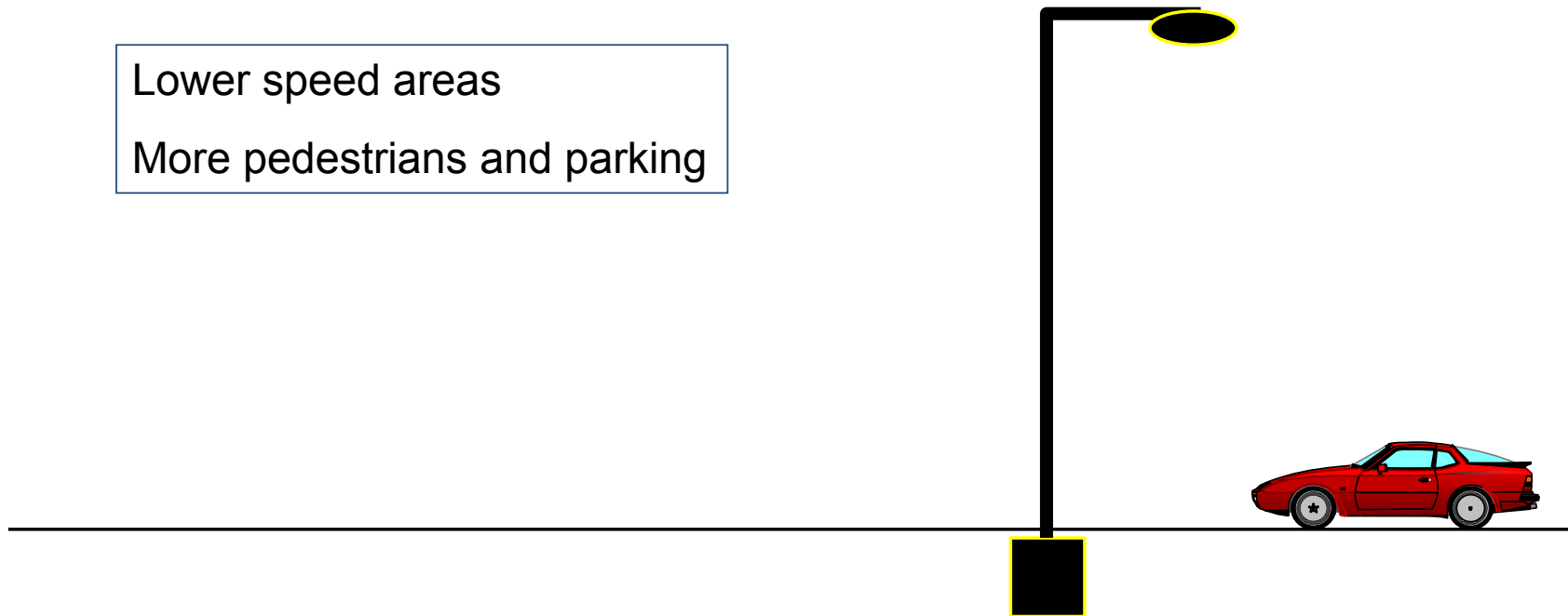


Impact Absorbing Poles

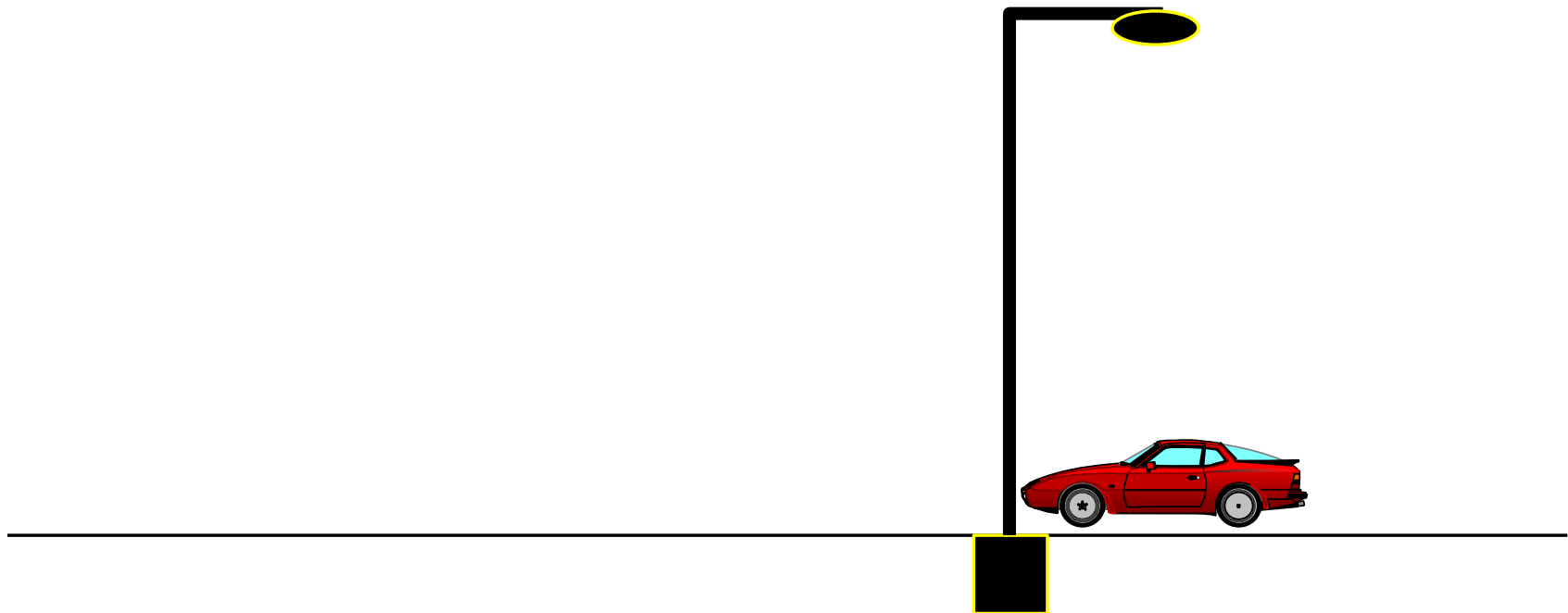
Impact Absorbing Pole

Lower speed areas

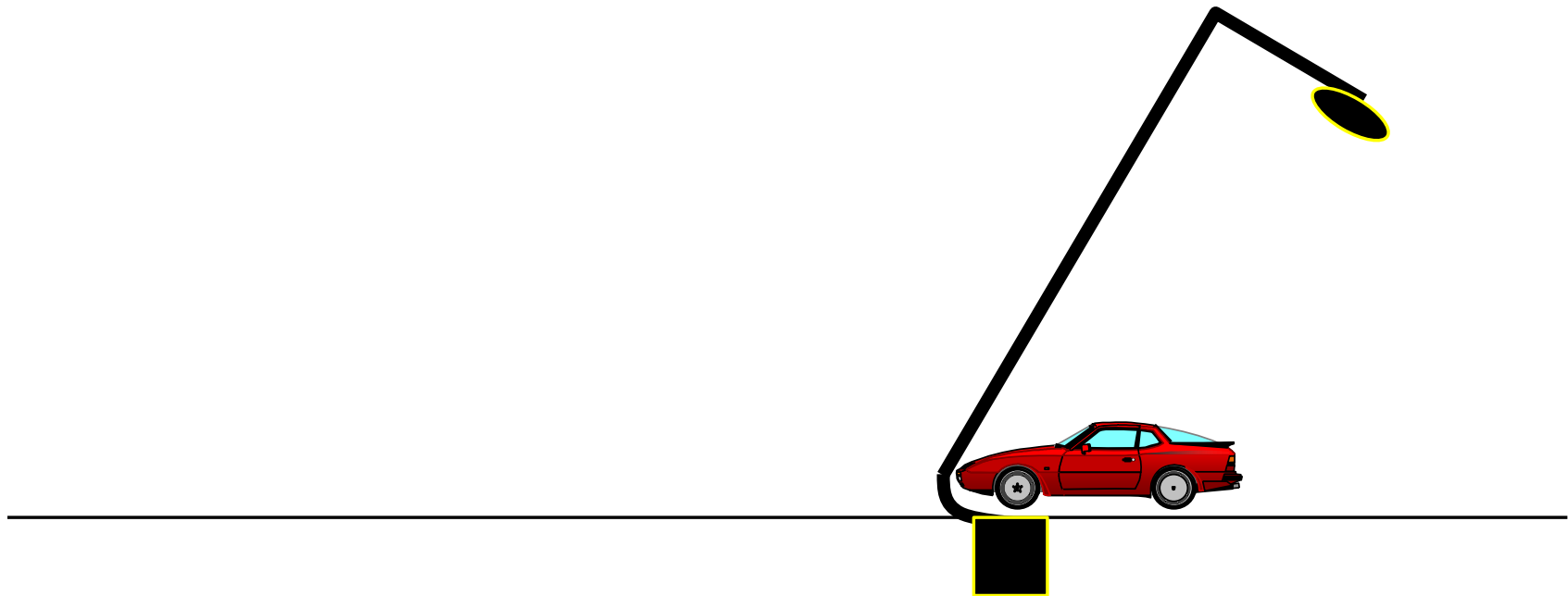
More pedestrians and parking



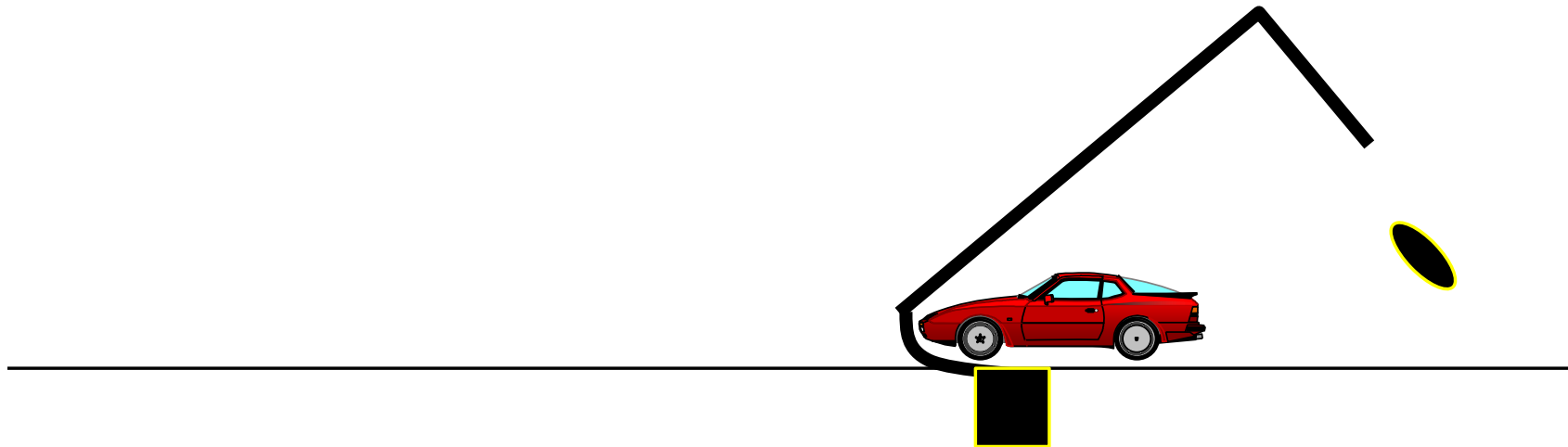
Impact Absorbing Pole



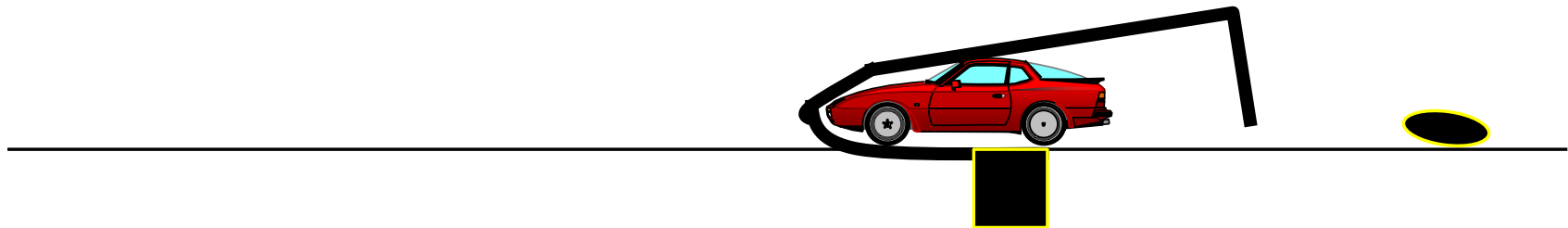
Impact Absorbing Pole



Impact Absorbing Pole



Impact Absorbing Pole





Impact Absorbing Pole





**If you do not want to see a
video of a violent crash...**

...turn away now



Why do we use safety barriers?

To protect the occupants of errant vehicles from more serious injuries than...

Remember that safety barriers can be roadside hazards – ensure they are correctly designed, installed and maintained



-
- There are several key design issues to check – to ensure the proposed barriers will be safe.
 - And remember, the common W-beam steel barrier can only be relied upon to contain cars.
 - Trucks and buses may be constrainedbut not always!



Safety barriers

Remember that safety barriers can be roadside hazards – unless you have good funding and can saturate your highways with flexible barrier, try to design new roads to avoid having to use barrier.

Three groups of barriers



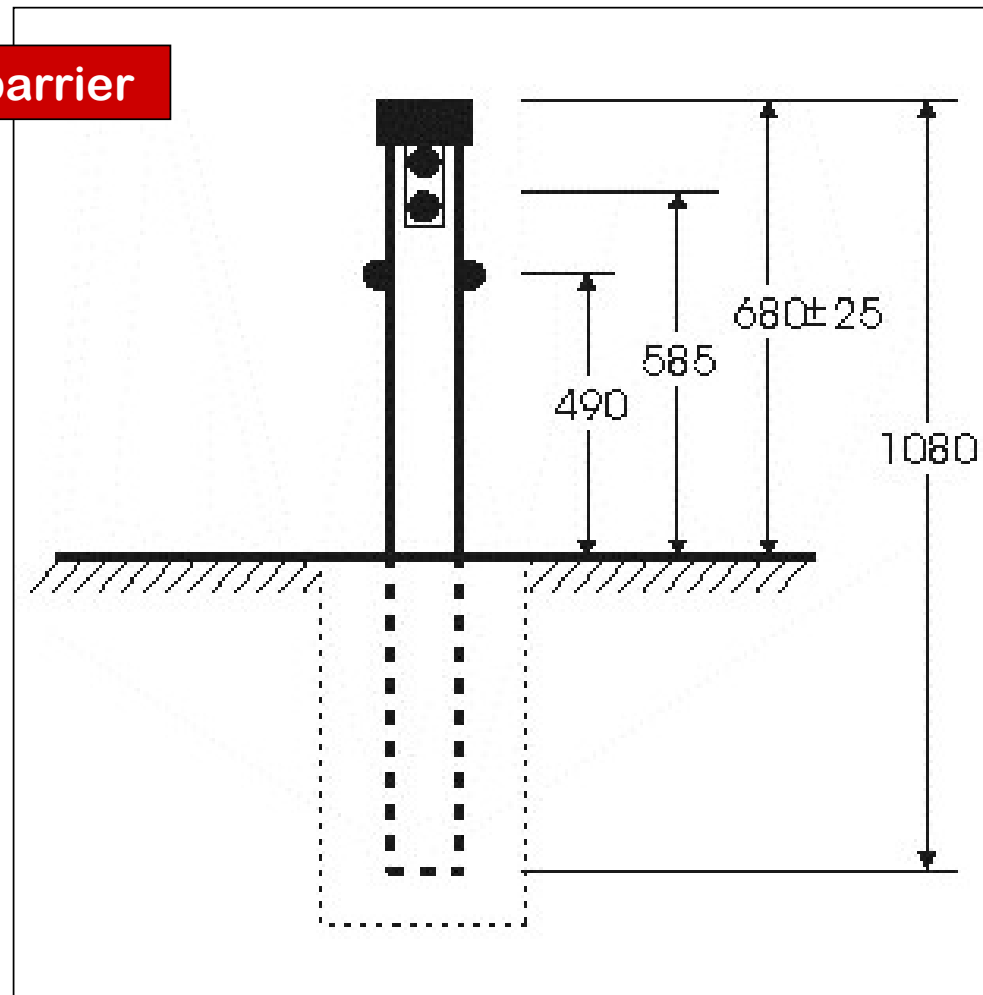
- Flexible barriers
- Semi-rigid barriers
- Rigid barriers

Three groups of barriers

Flexible barriers

- Deceleration forces on occupants are below the 20g critical impact force.
- Offer greater deflection (typically 2m), and thus impose lower deceleration forces on occupants.
- Therefore, less injuries to occupants.
- Safer!
- Quickly restored when struck.

Flexible barrier



Brifen Wire Rope Safety Barrier



Brifen Wire Rope Safety Barrier



Flexfence Wire Rope Safety Barrier





Filmed under test conditions



Ezy-Guard





Ezy-Guard





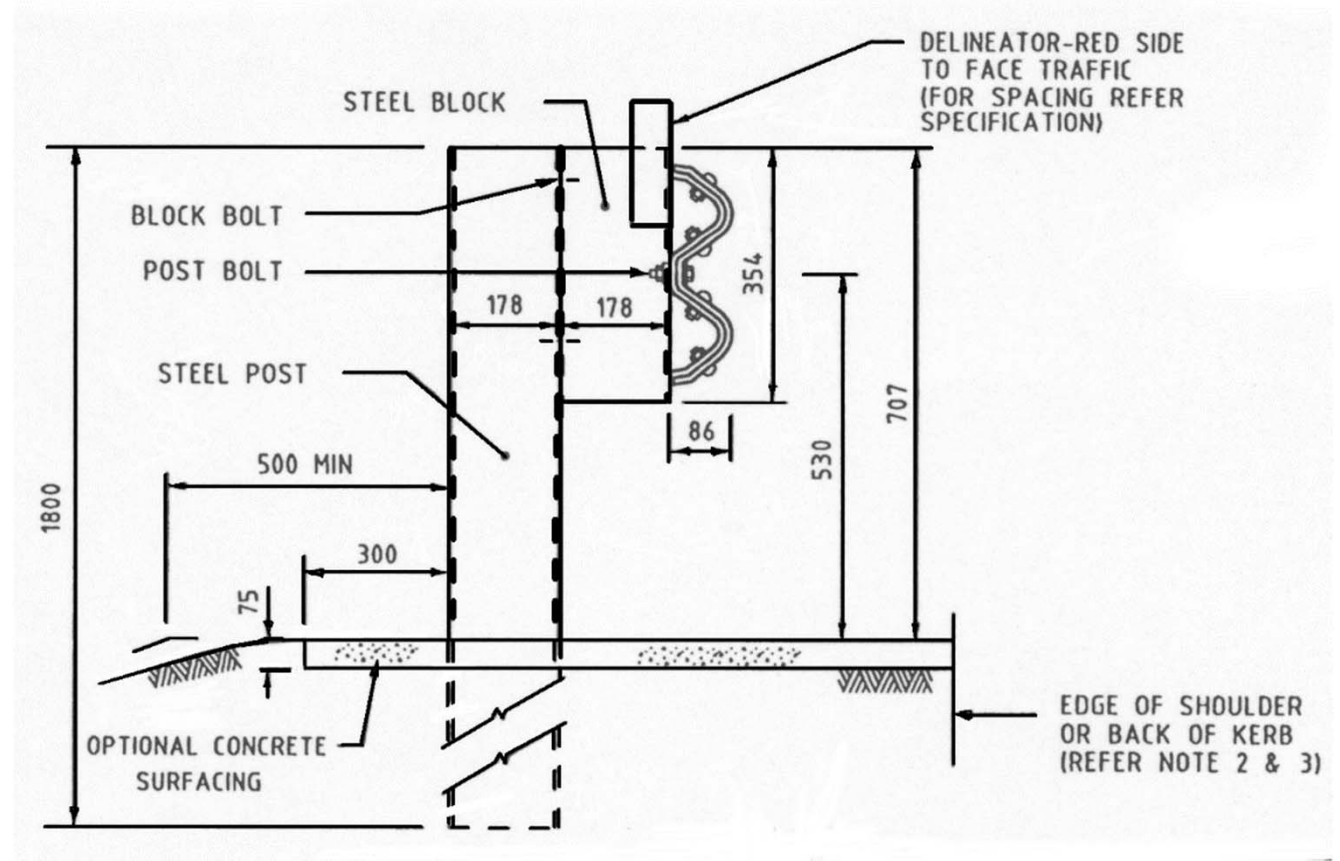


Three groups of barriers

Semi-rigid barriers

- Mainly W-beam
- Widely used
- Deflects (but not as much as WRSB)
- Block outs prevent snagging
- Repairs take more time
- Safe end terminals are vital

W Beam Safety Barrier





Semi-rigid barriers

- Deflect up to 1.5m (with 2.5m post spacing)
- Can reduce deflection by reducing post spacing

Semi-rigid barriers

- Deflect – but not as much as WRSB
(allow 1.5m minimum offset to the hazard with 2.5m post spacing)
- Halving post spacing reduces deflection by 20-30%





Always check that the beam is overlapped in the direction of travel. (This example is not safe!)

Semi-rigid barriers



Open box beam



Thrie beam



Three groups of barriers



Rigid barriers

- Cast in place or set in place concrete
- No deflection
- Minimal repairs necessary
- End treatments vital

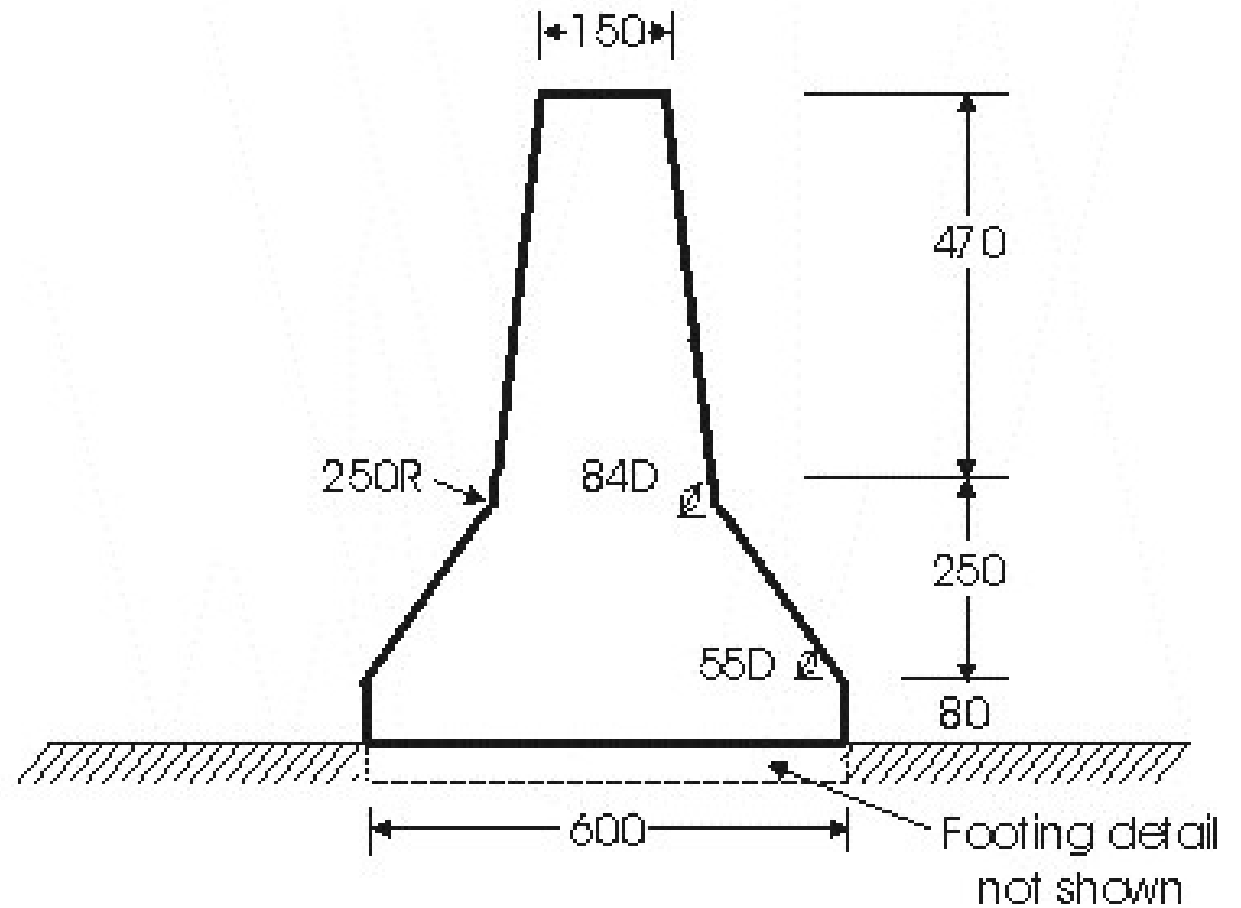
Rigid barriers

- > Cast in place or set in place concrete
- > No deflection during impact
- > Minimal repairs are usually necessary
- > But safe end treatments vital



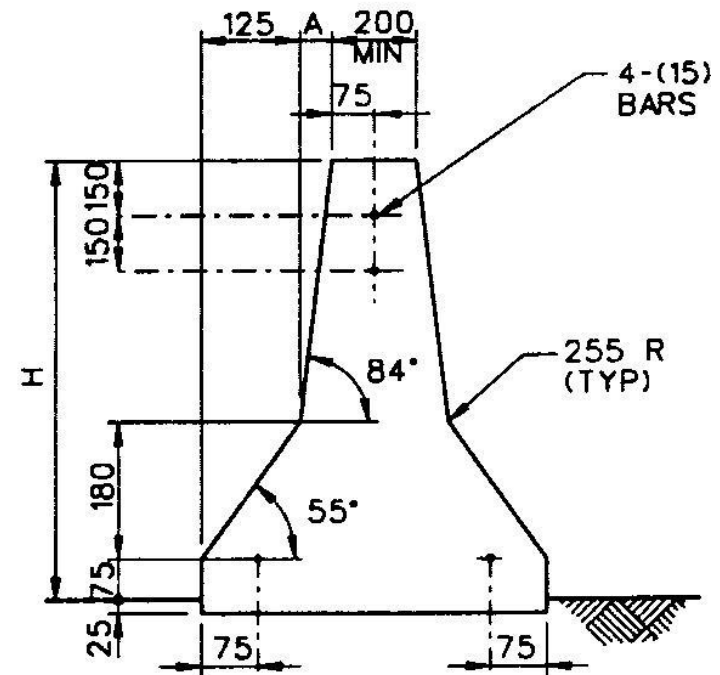
New Jersey Barrier

Rigid barrier



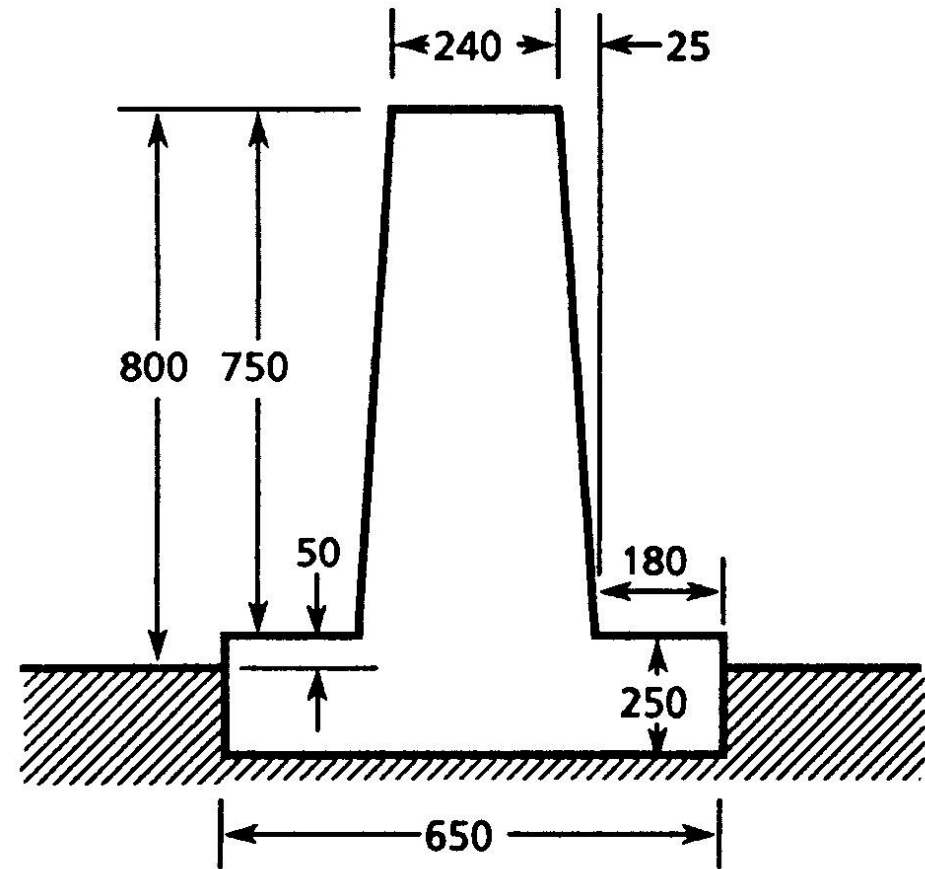
Rigid barrier

F Profile Barrier



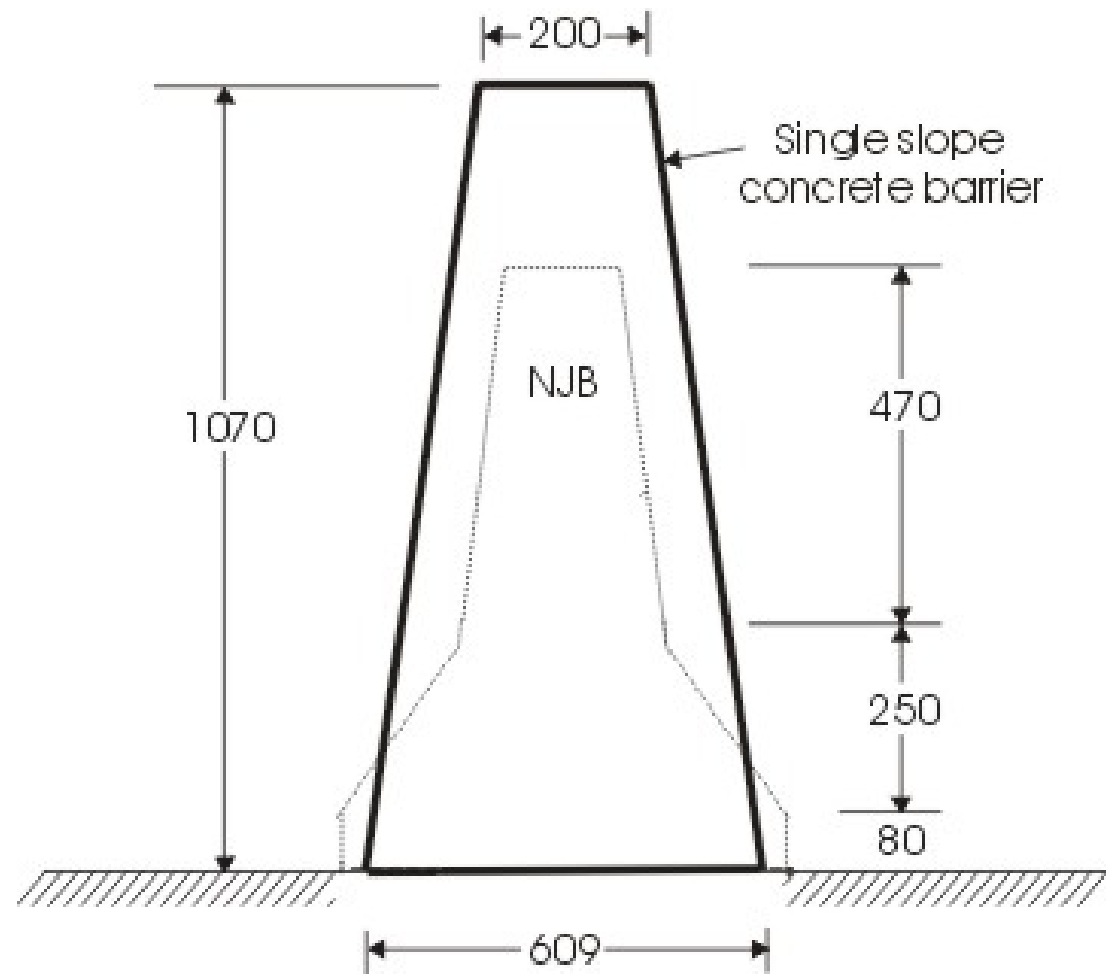
Rigid barrier

Vertical Face Barrier



Rigid barrier

Constant (single)
Slope Barrier

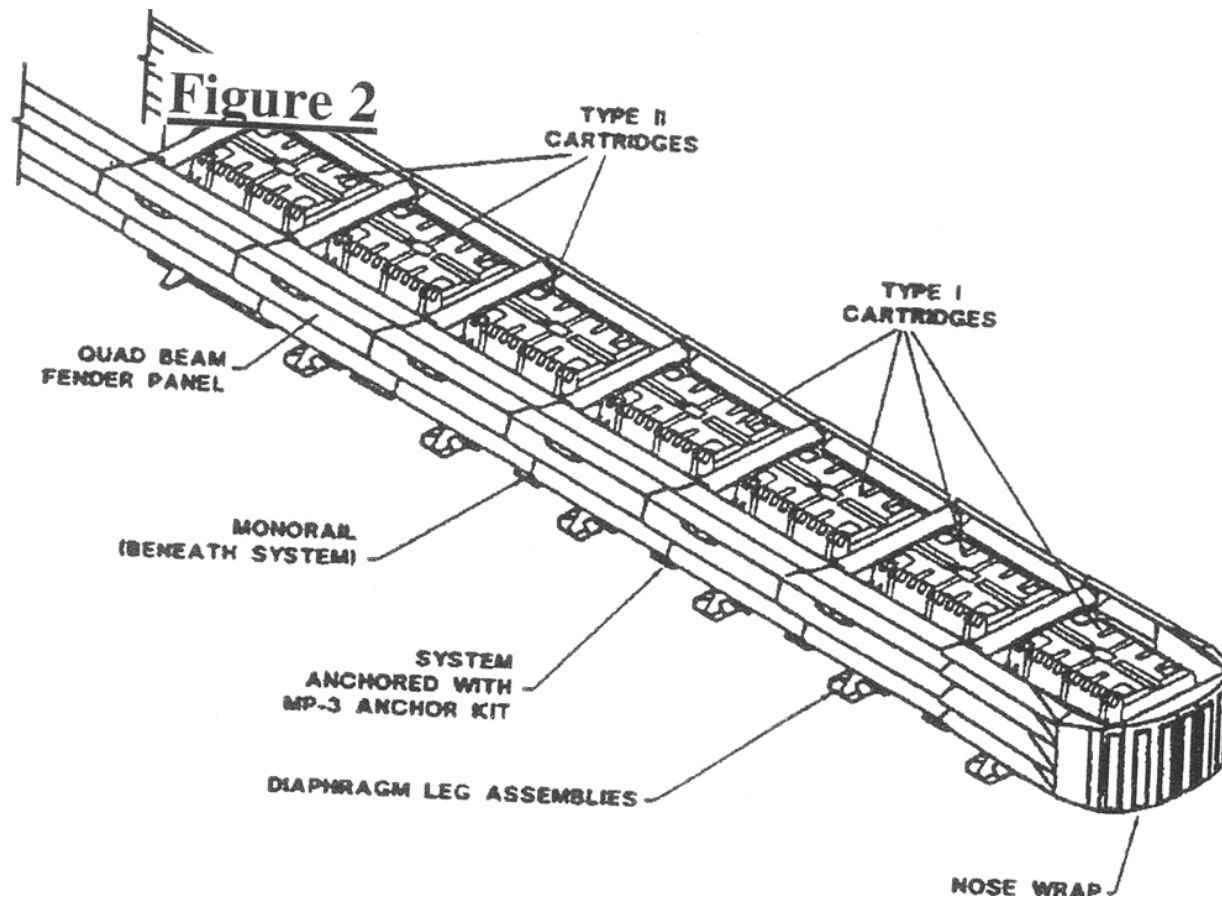








Rock gabion basket – hair-pin bend, Nepal



Impact Attenuator



Impact Attenuator



Impact Attenuator



Temporary barriers and attenuators

24th December 2014



Temporary barriers and attenuators

30th December 2014





Inside an impact attenuator cartridge

Raptor





THE THREE I's

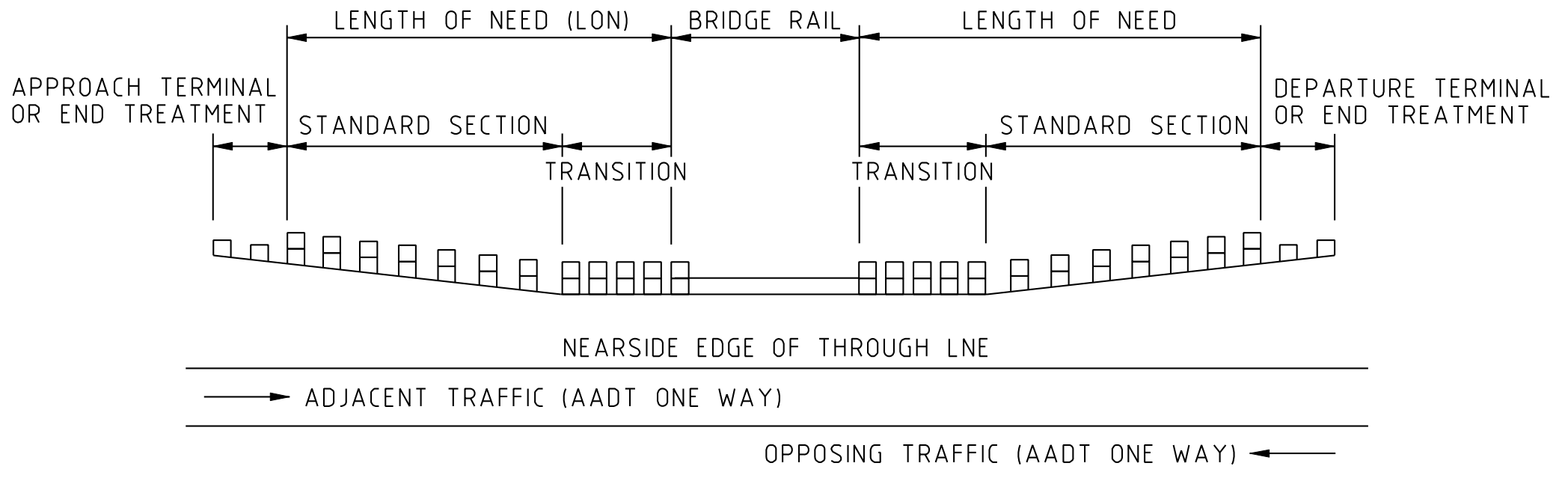
- IDENTIFY
- INVESTIGATE
- IMPLEMENT

Nine things to look for when checking barriers

To outline some of the main things to think about when you are inspecting a road and there is barrier involved.

- Length of need
- Barrier length
- Offset to the barrier
- Deflection
- Proximity to kerbs (avoid vaulting)
- Stiffen (prevent pocketing)
- Mounting height (watch for vaulting)
- End treatments (prevent spearing)
- Working Width (snagging)

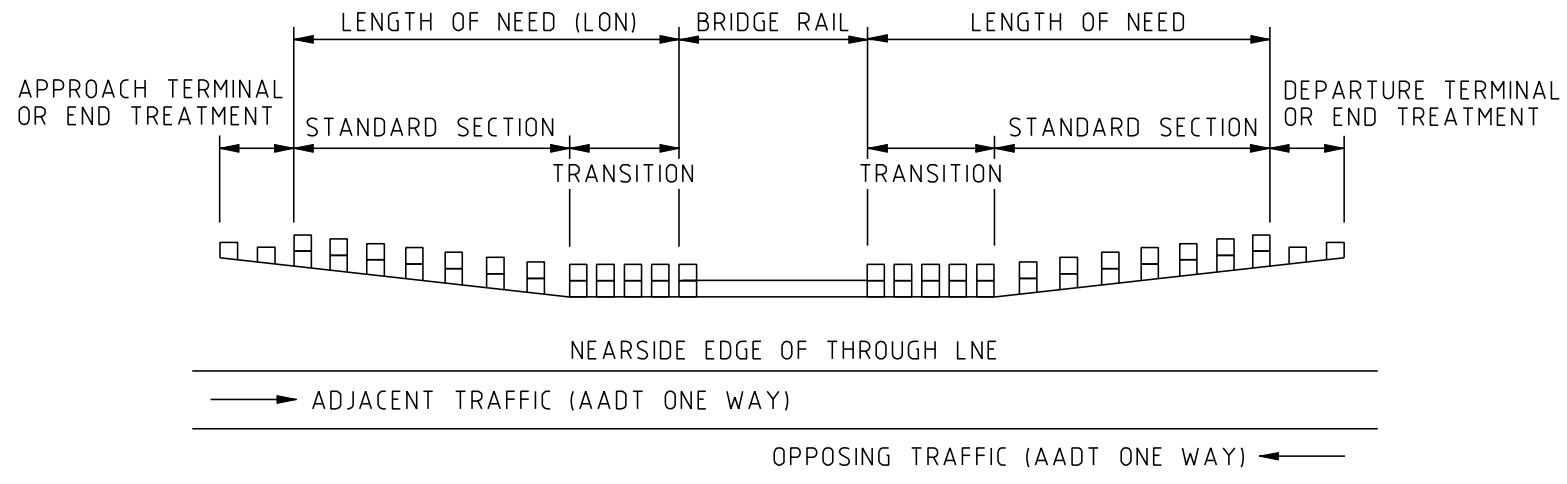
The length of barrier needed to shield the hazard or area of concern





Too short. Does not satisfy
the Length of Need





2 Barrier length

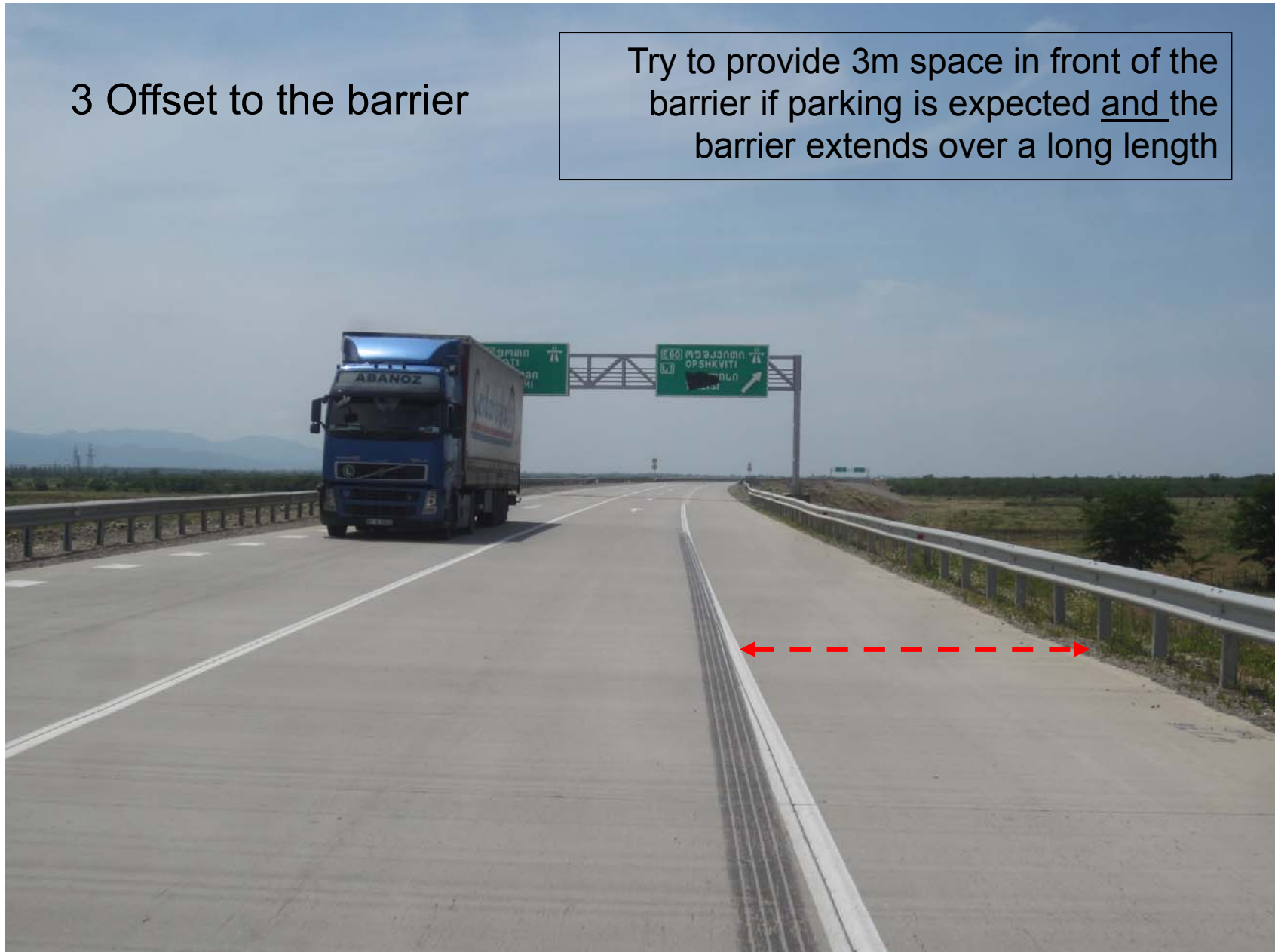
The LON (nearside) plus the LON (offside) plus the length of the hazard, plus the end terminals

3. Offset to the barrier from the traffic lane should generally be as far as possible except for rigid barriers

- Rigid barriers – less than 4 m from lane (to minimise angle of impact)
- Wire rope and W beam barriers – as far as practical
- Try to provide space for broken down vehicles to stop
 - 1.5m desirable minimum
 - 1.0m minimum
 - 0.6m absolute minimum

3 Offset to the barrier

Try to provide 3m space in front of the barrier if parking is expected and the barrier extends over a long length



4 Deflection space
between the barrier
and the hazard



Always check that the barrier rail is at least 1.5m from the hazard (much more for flexible barrier) – to allow for deflection during impact.



5 Avoid kerbing near barriers

Have a smooth, paved surface between the traffic lane and the safety barrier (so that an impacting vehicle can hit the barrier at the correct height)

Avoid kerbing near barriers

Kerb & Channel – do not use on high speed roads. Place barrier at the kerb face or more than 3m behind it.

Semi-mountable kerb – place the barrier either 0 -1m, or more than 3m, behind the kerb.

Mountable kerb – no restrictions on where to place the barrier.





6 Avoid “pocketing”

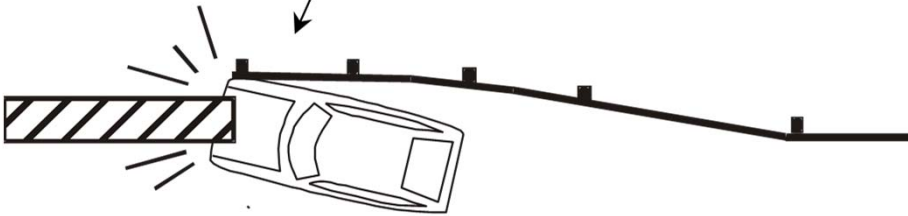
Gradually stiffen a semi-rigid barrier as it connects to rigid barrier (to keep an impacting vehicle away from the end of the rigid barrier)



Is this bridge parapet “safe”?

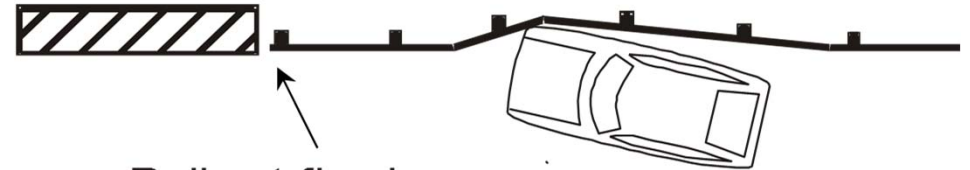
“Pocketing”

Posts and guardrail deflect and leave the parapet exposed



Concrete Parapet

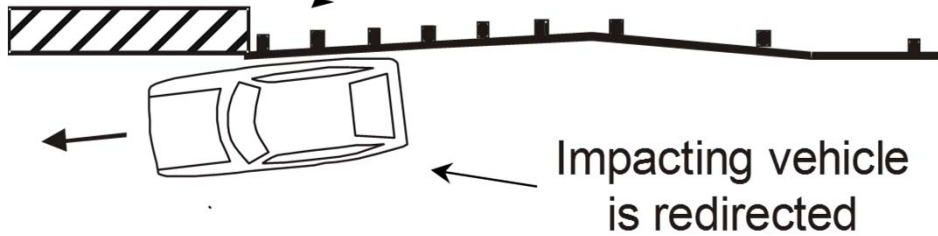
Rail not fixed to parapet





No "pocketing"

Fixed guardrail transition
shields parapet



Impacting vehicle
is redirected



Guardrail stiffened with
closely spaced posts

Concrete
Parapet



Guardrail fixed to parapet to
provide a continuous barrier





When going from a less rigid barrier to a more rigid system, it is necessary to create a gradual increase in stiffness between the barrier systems so that vehicle “pocketing”, snagging or penetration is prevented along the transition.



7 Mounting height

Every barrier needs to be correct height – to reduce the risk of vaulting, or “under sliding” (so the impacting vehicle can hit the barrier at the correct height)



Too high





Too low





8 Safe terminals

Every length of barrier has a beginning, and an end. Both ends need safe terminals.

Unsafe! There is no terminal - a safe terminal is needed to build up barrier strength and to avoid spearing vehicles.







Because unsafe terminals spear through impacting vehicles and kill people



We must eliminate unsafe terminals



Unsafe! A safe terminal is needed to avoid spearing vehicles. Very unsafe!

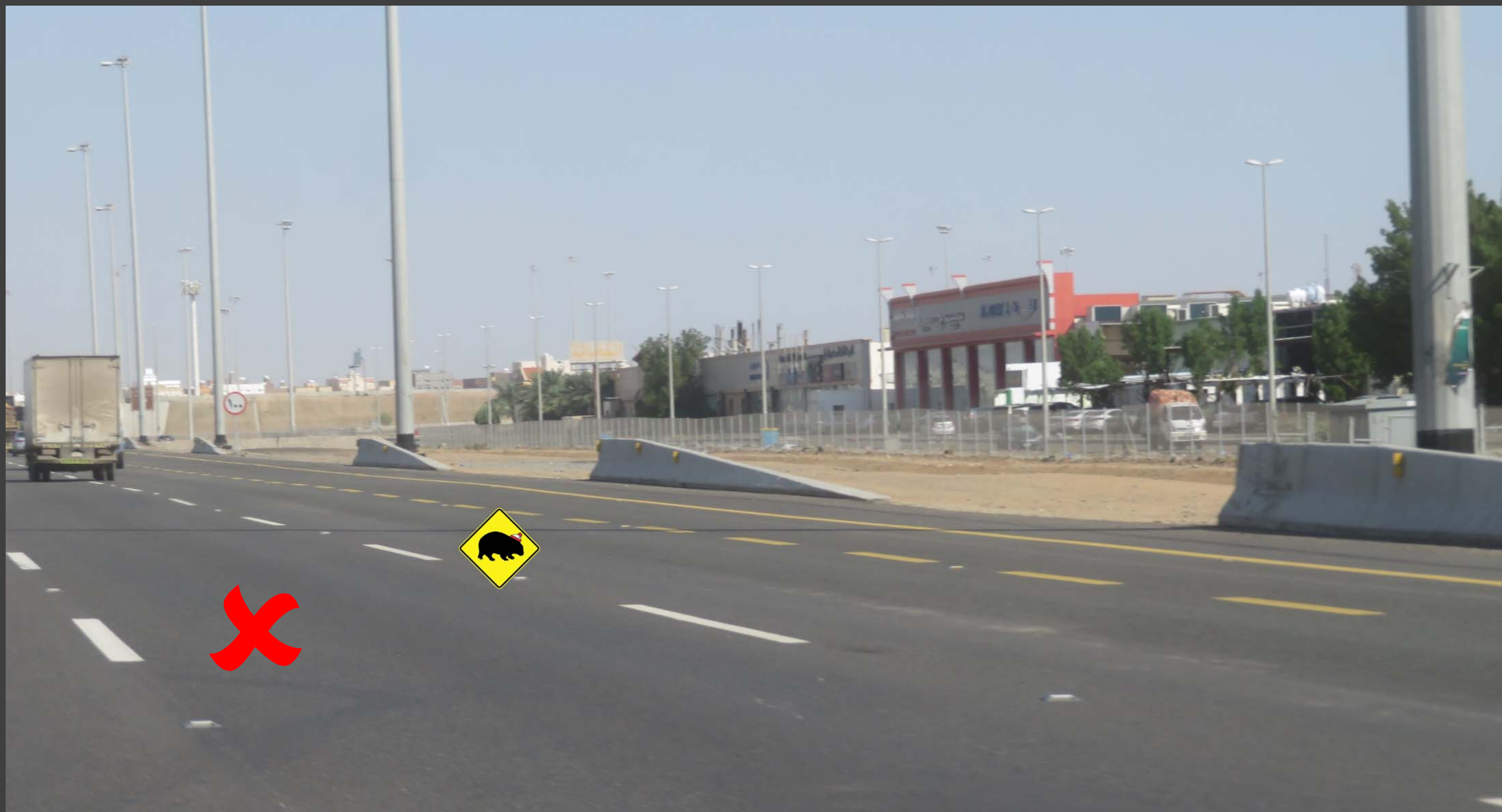


Sloped end treatments are dangerous. If struck, the vehicle may become airborne or overturn.



Sloped end treatments are dangerous. If struck, the vehicle may become airborne or overturn.





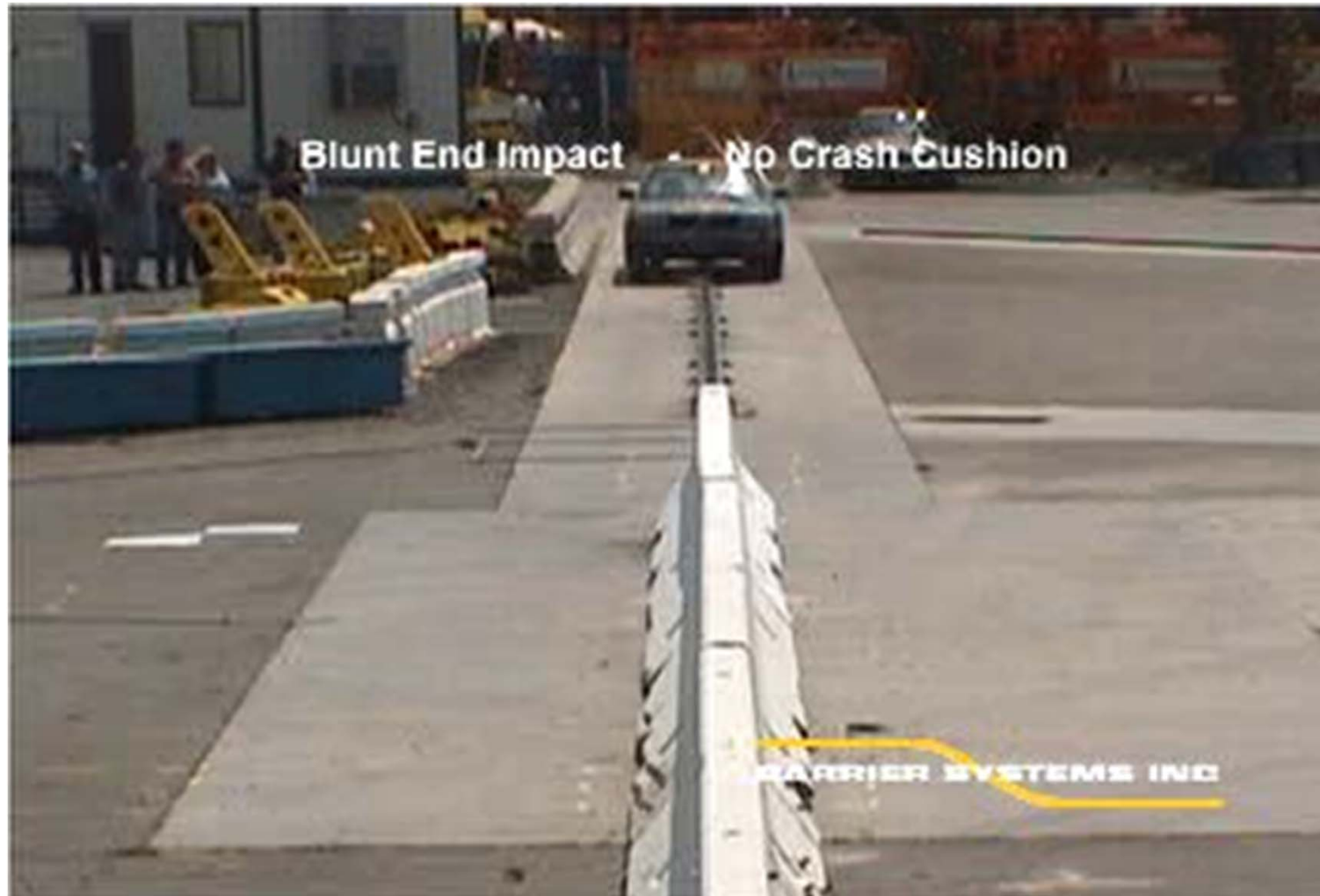


Every barrier needs safe, effective terminals – on both ends





Collisions with the ends of concrete barriers kill people. Never leave such hazards within the clear zone on your roads.











Impact Attenuator

9 Working Width

The barrier must be far enough from any upright hazard to prevent “snagging” by large/tall vehicles





Working width

To prevent snagging of
high loads on piers



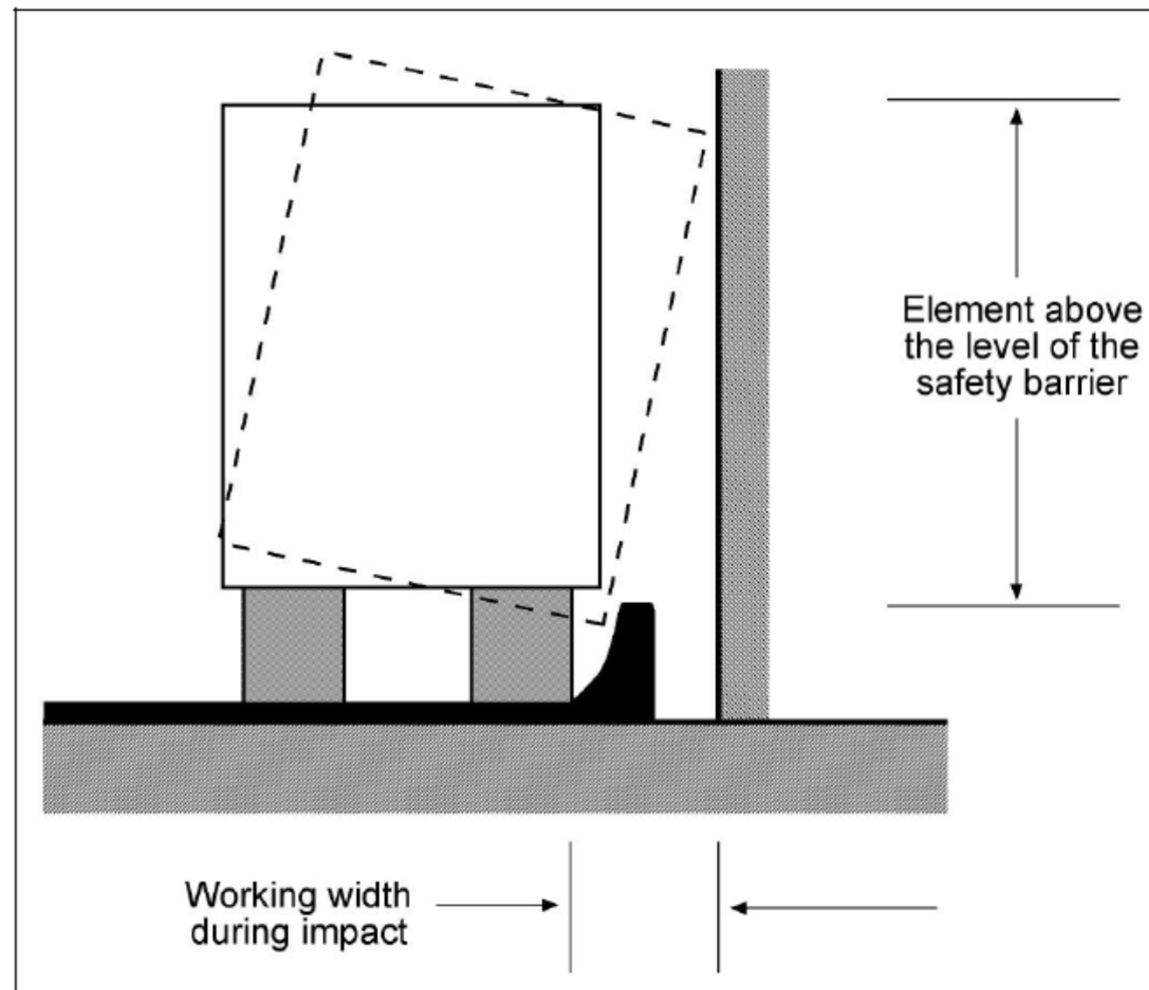


Table 17 Barrier Working Width

Situation	Dynamic Deflection	Roll Allowance	Working Width
W-beam protecting slopes (can be penetrated by trucks)	1.7	1.1	2.8 (Light vehicles)
Concrete barrier protecting sign gantry or pedestrian bridge	0.0	3.0	3.0 ¹⁷ (Trucks)
Concrete barrier protecting road bridge	0.0	2.1	2.1 (Trucks)

Working width -

....includes the barrier deflection plus the roll distance of an impacting high vehicle. It is a necessary consideration when designing barriers to shield hazards such as bridge supporting piers on expressways from impacts by large trucks.
(For rigid barriers this is also known as the Zone of Intrusion).

Working
width – OK



A few other things
to finish with...





Provide at least 500mm (post to hinge point) to ensure solid post installation

Horizontal railing
is deadly...





Horizontal railing
is deadly...





Thank you – I look forward
to your questions

Did you count all Wally the Wombats?