Welcome to the CAREC

“Road Safety Engineering” Workshop

- for professionals in Kazakhstan

Module 2 Roadside hazard management

Thursday 14th October 2021

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

Single vehicle run-off-road crashes

In USA, in 2012 approximately 21% of the 33,800 road deaths occurred in single vehicle run-off-road crashes.

In Australia, 40% of all fatalities occur in run-off-road crashes

In USA (2005 FHWA figures) – they were 31%of fatal crashes but just 16% of all crashes

Wear your seat belt!

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

…turn away now

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

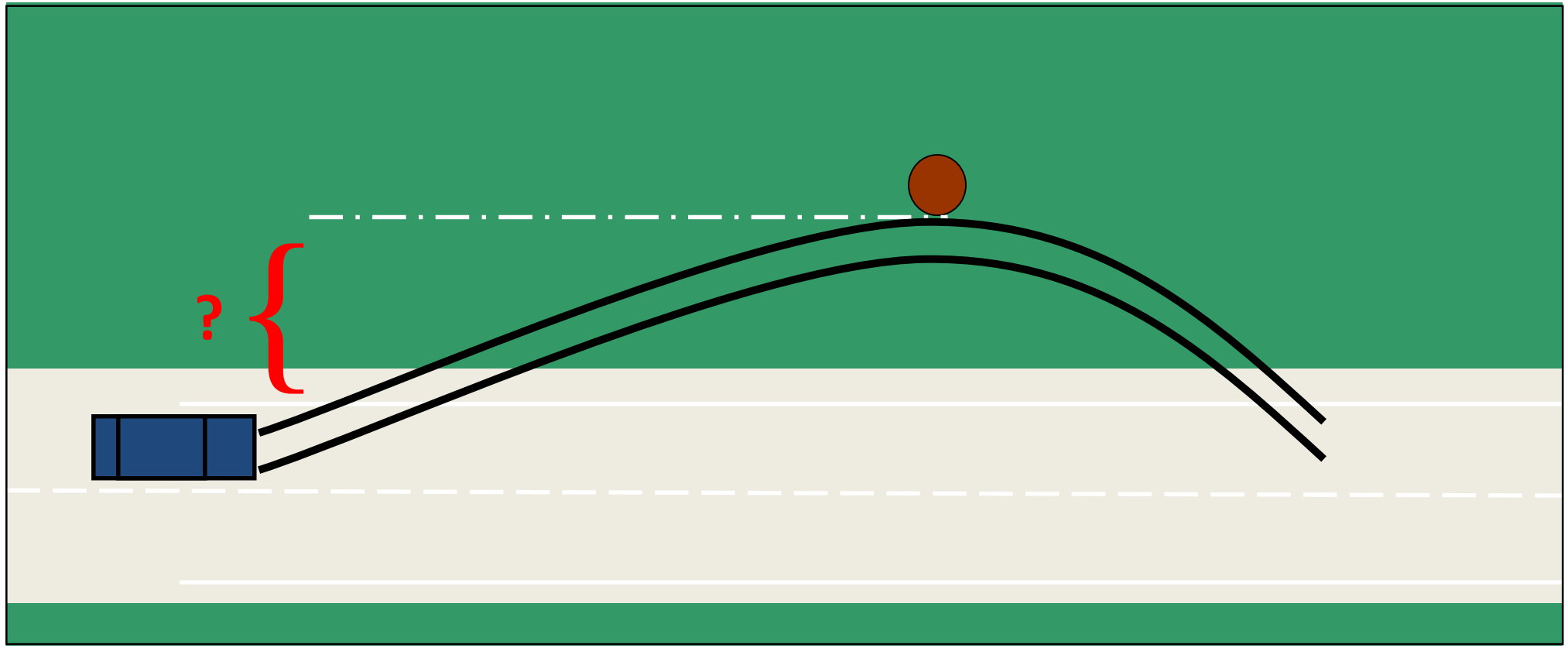
To provide a forgiving roadside environment, we need to ask…

- 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 ?

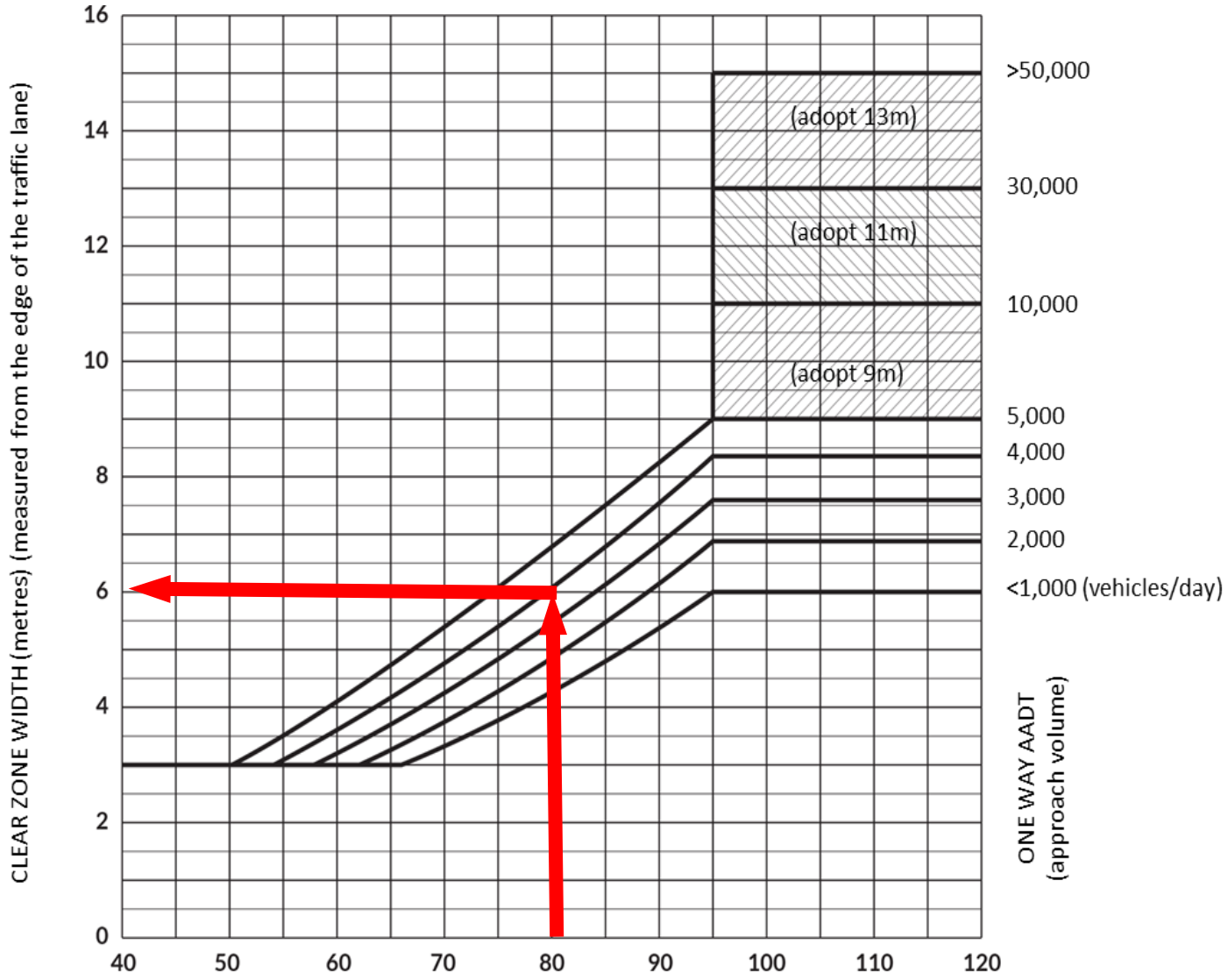


How do we determine the Clear Zone for a road?

A clear zone depends on:

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

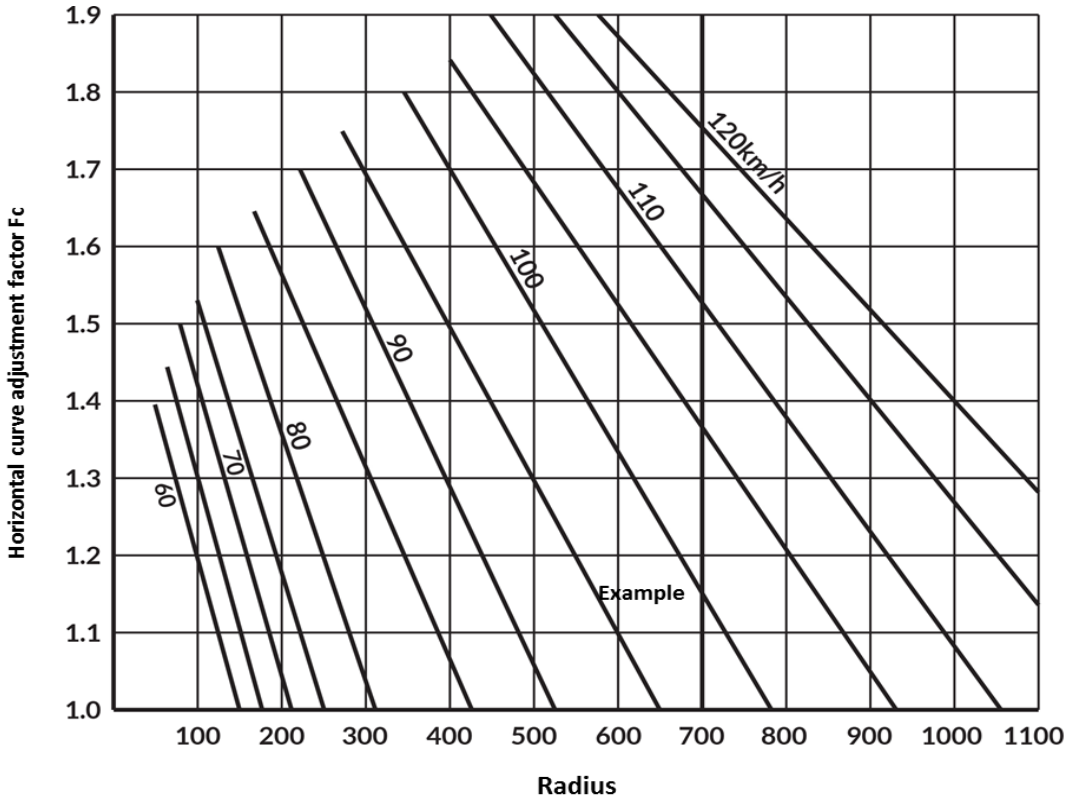
Figure 1 Clear Zone for Straight Roads



EXAMPLE 1 If the operating speed is 80km/h and the one way AADT is 4,000 vehicles/day, the clear zone width is 6m

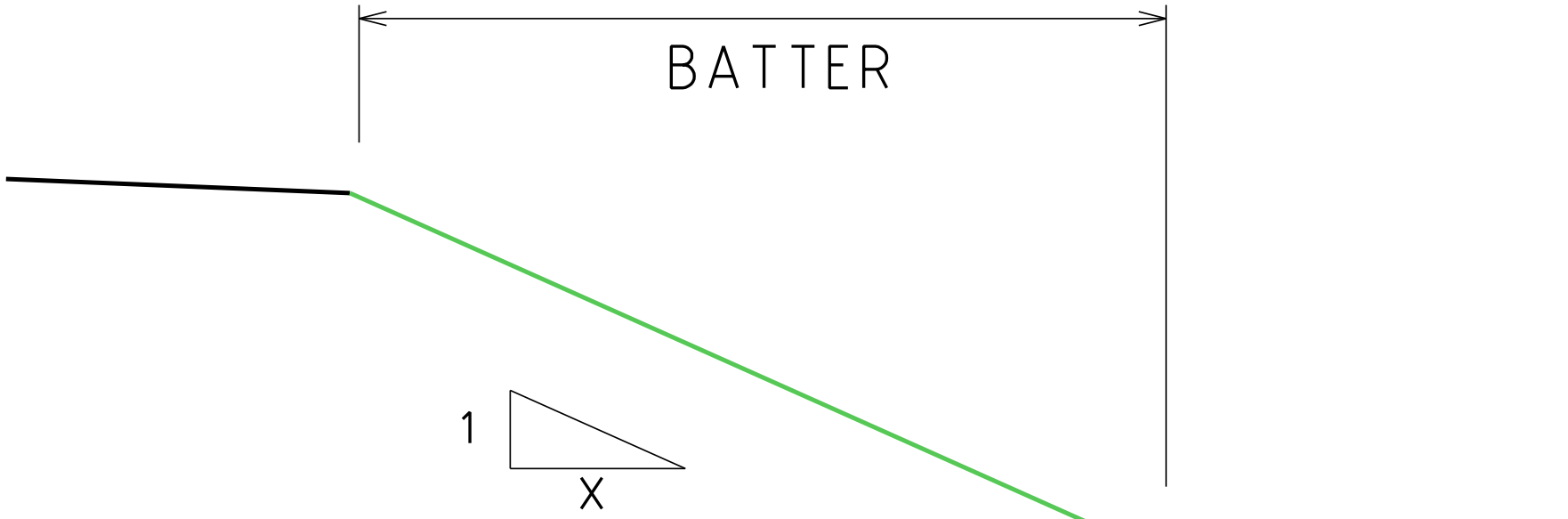
EXAMPLE 2 If the operating speed is 100km/h and the one way AADT is 20,000 vehicles/day, the clear zone width is 11m (adopt range 10,000 - 30,000 vehicles/day)

Figure 2 Clear Zone Adjustment Factors for Curves



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

Example:
On a 700 metre radius curve with an Operating Speed of100km/h, the graph suggests an Fc 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

So, what is a roadside hazard?

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


POLICE
11473
11473


GOKDEPE
TÜRKMENBAŞY
METJIT
AŞGABAT
MARY


3000-СОЛАГИИ ХИСОР МУБОРАК
9485 в 01


TATA
NATIONAL
PERMIT
LOADER
PUBLIC
RAJASTHAN
BIHAR-BENGAL
JHARKHAND


المملكة العربية السعودية
وزارة النقل
KINGDOM OF SAUDI ARABIA
MINISTRY OF TRANSPORT
محطة وزن
جميع الشاحنات
WEIGH STATION
FOR ALL TRUCKS


ЧИНГИС ХААН
НИСЭХ БУУДАЛ
Chinggis khaan
airport
TZ211
60
Gz009
СОНГИНОХАЙРХАН
ДҮҮРЭГ
Songino khairkhan
district
ЗУУНМОД
Zuunmod 43
4889 УНГ
9973
УБГ
0339 УНО
ХҮҮГҮЙ
ЗӨӨЛ
SEOUL


50


MEAT KATIE
FRI 1 SEPT


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

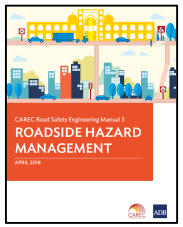
- IDENTIFY
- INVESTIGATE
- IMPLEMENT

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



Determine the clear zone distance by following Section 2.2

Are there any hazards within the clear zone?

No → No action required

Yes

Can the hazard be removed?

Yes → Remove the hazard

No

Can the hazard be relocated at least to the edge of clear zone?

Yes → Relocate the hazard, hopefully beyond the clear zone

No

Can the hazard be modified to remove the danger?

Yes → Modify / redesign the hazard to remove the danger

No

No

Can the hazard be modified to remove the danger?

Yes → Modify / redesign the hazard to remove the danger

No

Can the hazard be modified to reduce its impact severity?

Yes → Replace the hazard with a device that will breakaway on impact

No

Can the hazard be shielded with safety barrier?

Yes → Install an approved safety barrier (or impact attenuator)

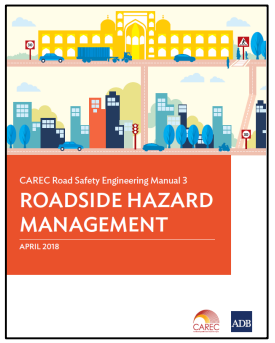
No

Has everything been done to “keep vehicles on the road” (with delineation, tactile edge lines, paved shoulders, guide posts).

Yes → Move on to the next “run-off-road” problem location

No

Keep vehicles on the road by signs, improving delineation, installing tactile edge lines, paving shoulders, installing guide posts.

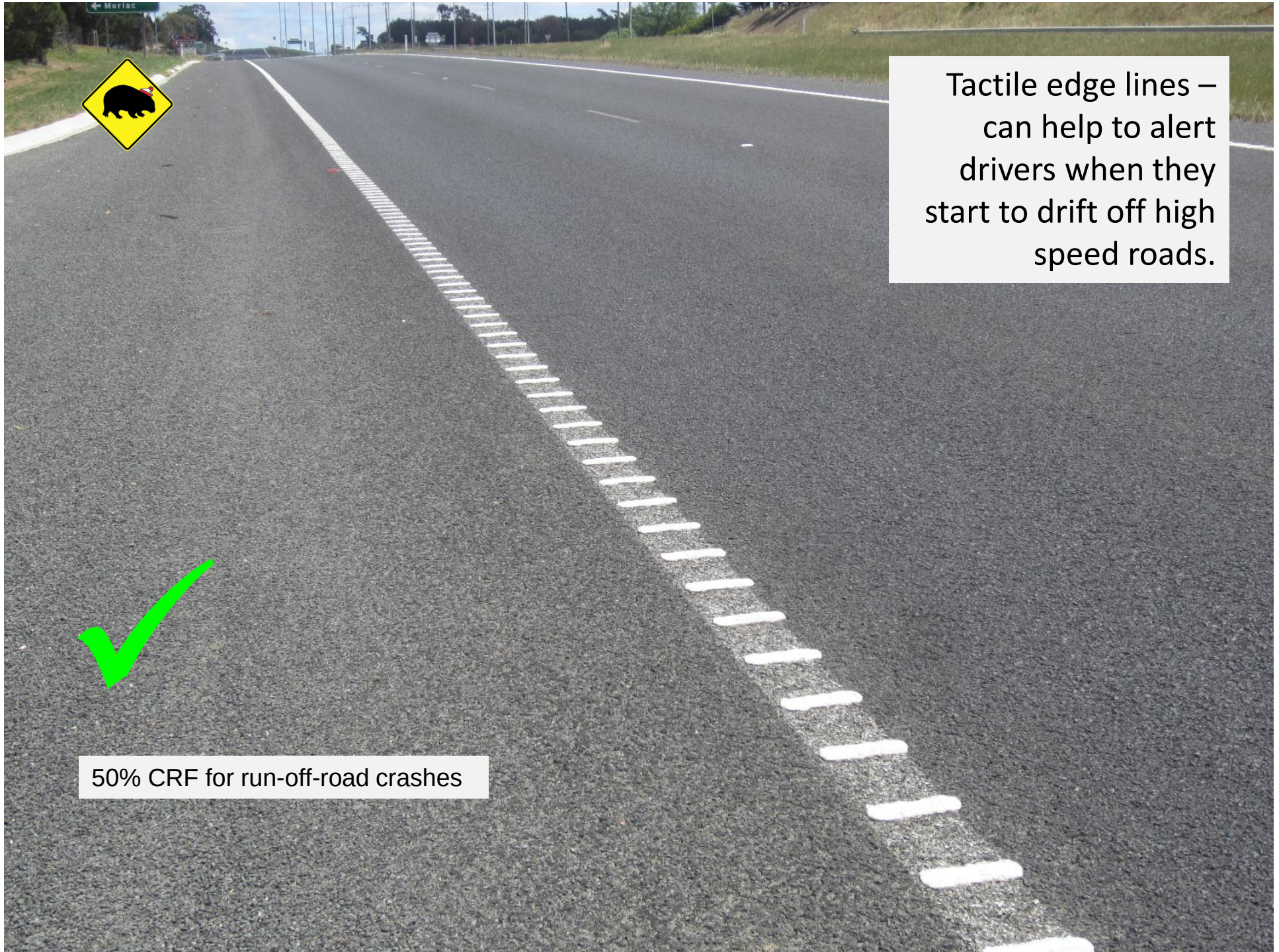


Has everything been done to “keep all vehicles on the road”?

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


VERBRUGGE


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
  (4:1or flatter)
- drivable culverts

Frangible lighting poles

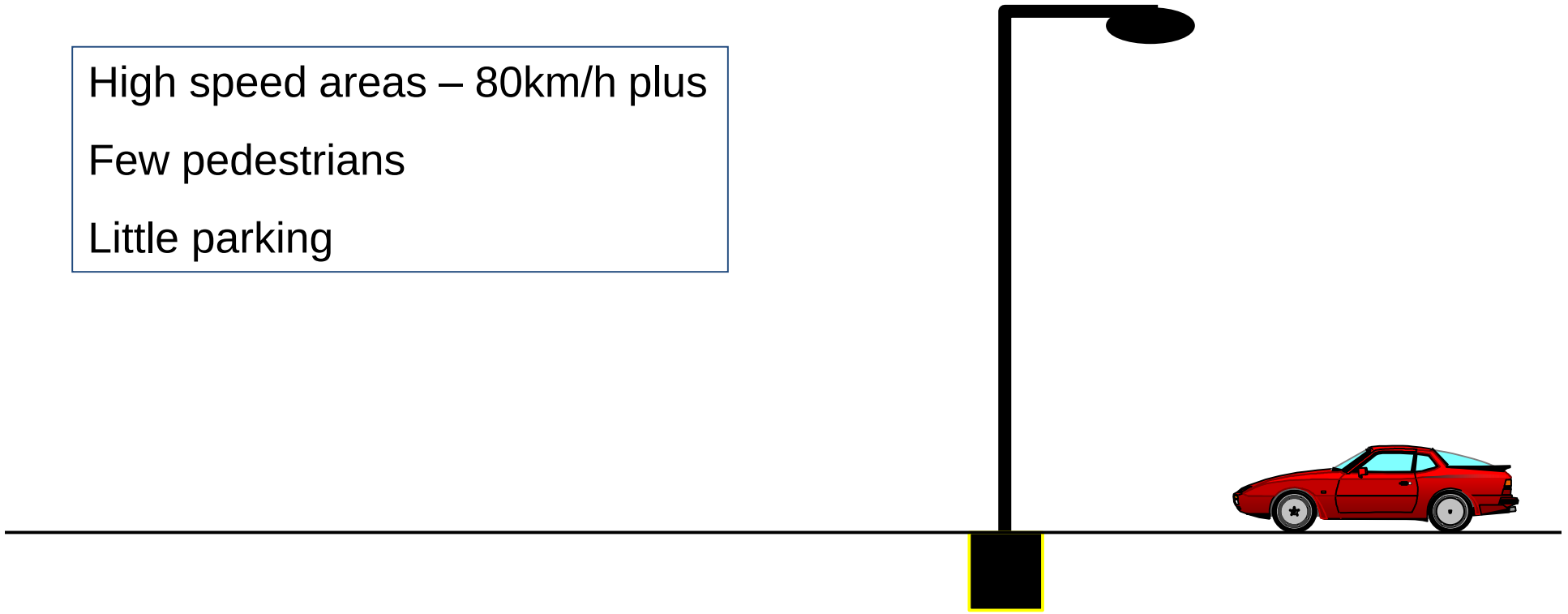
- slip base
- impact absorbing

Slip Base Pole

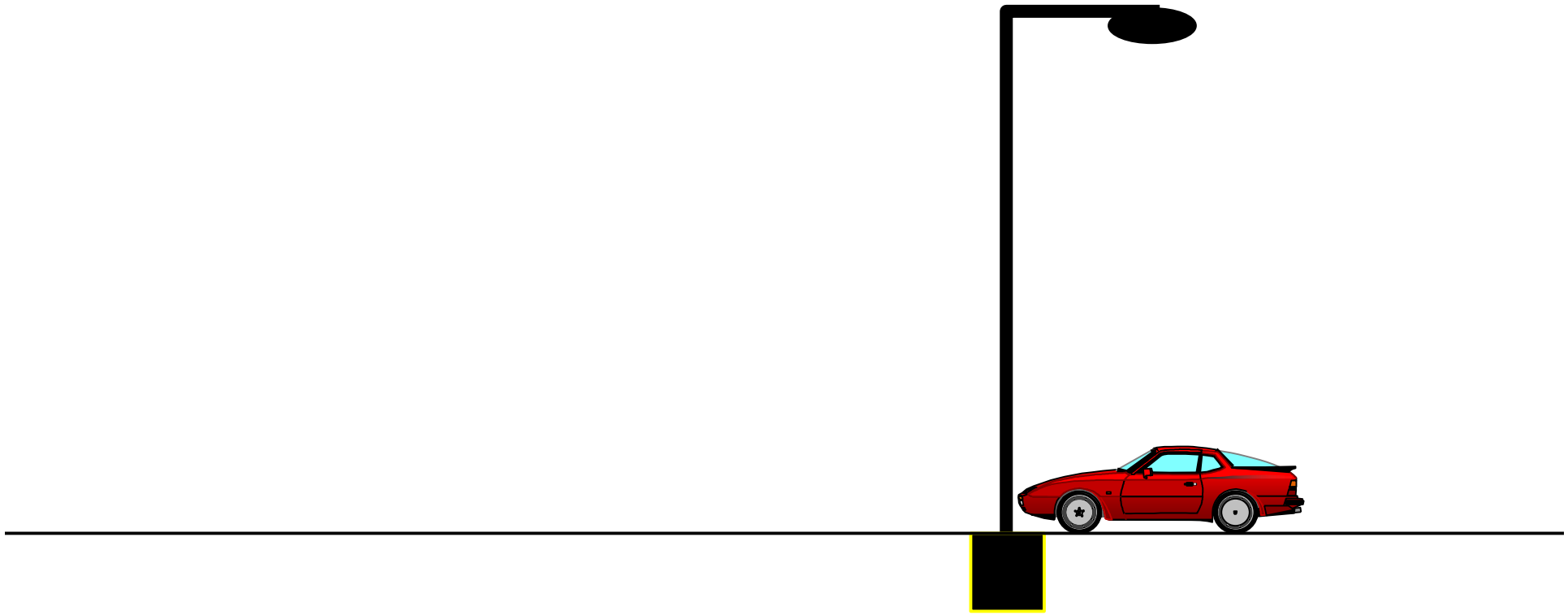
High speed areas – 80km/h plus

Few pedestrians

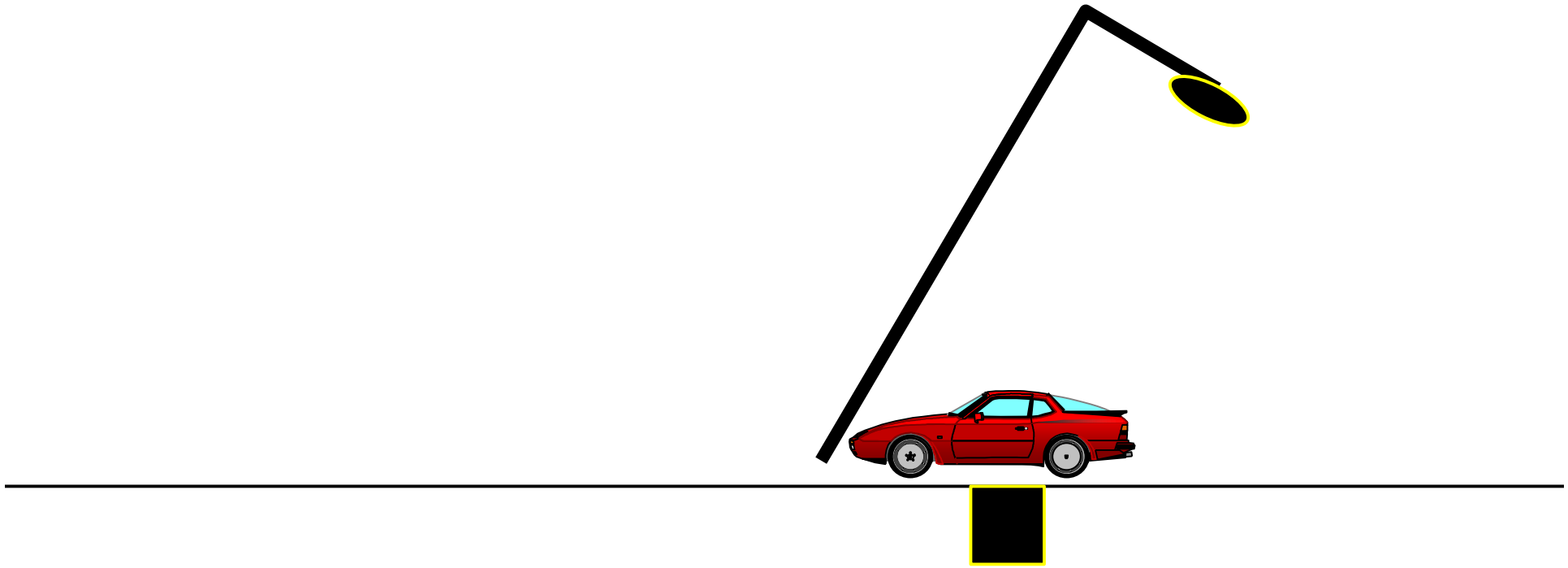
Little parking



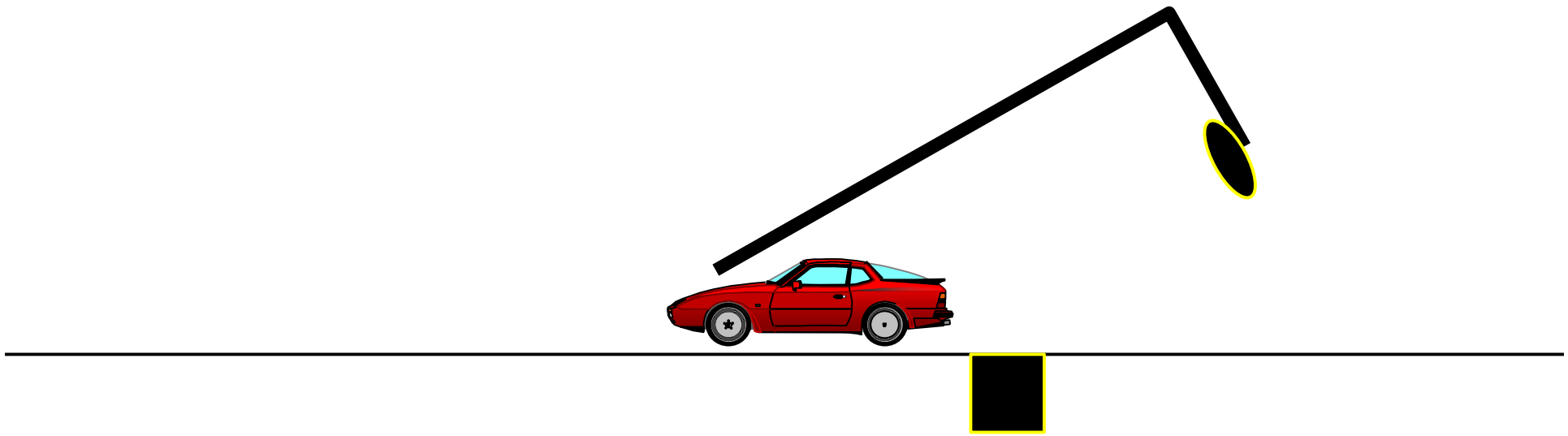
Slip Base Pole



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

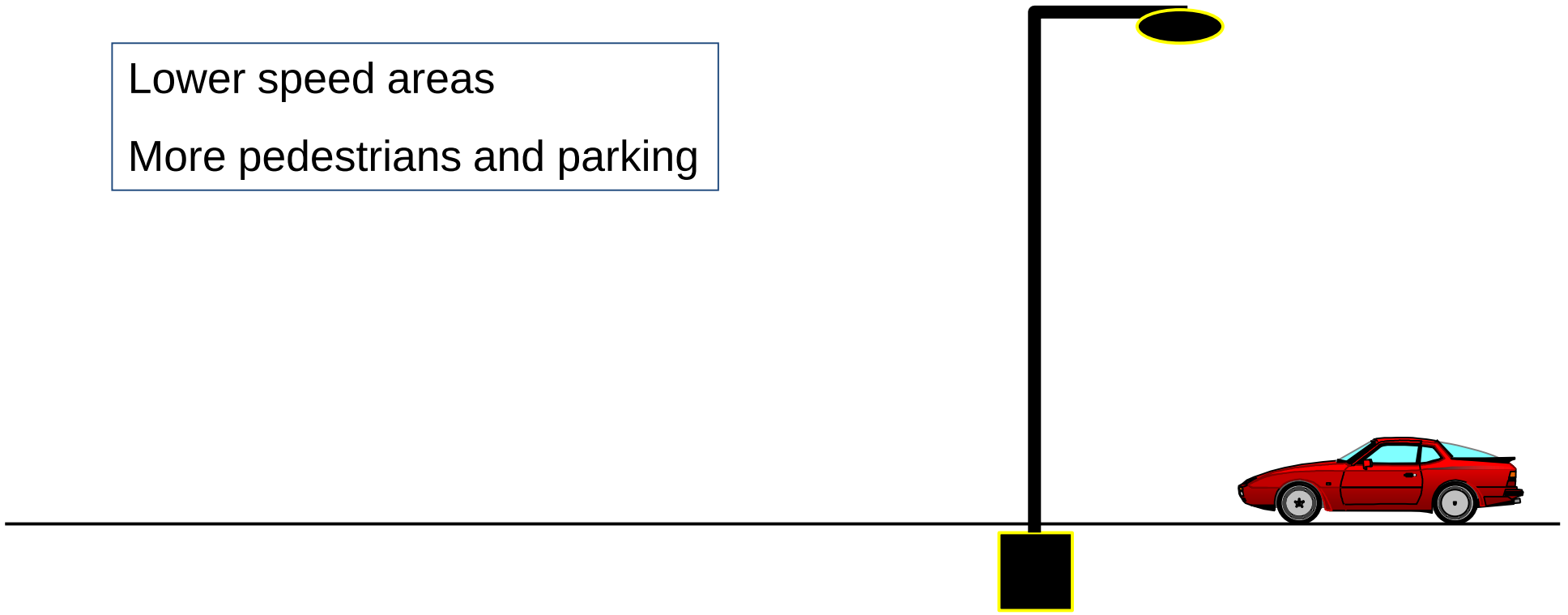

Slip base columns MUST be able to slip
when struck. DO NOT concrete them in!

Impact Absorbing Poles

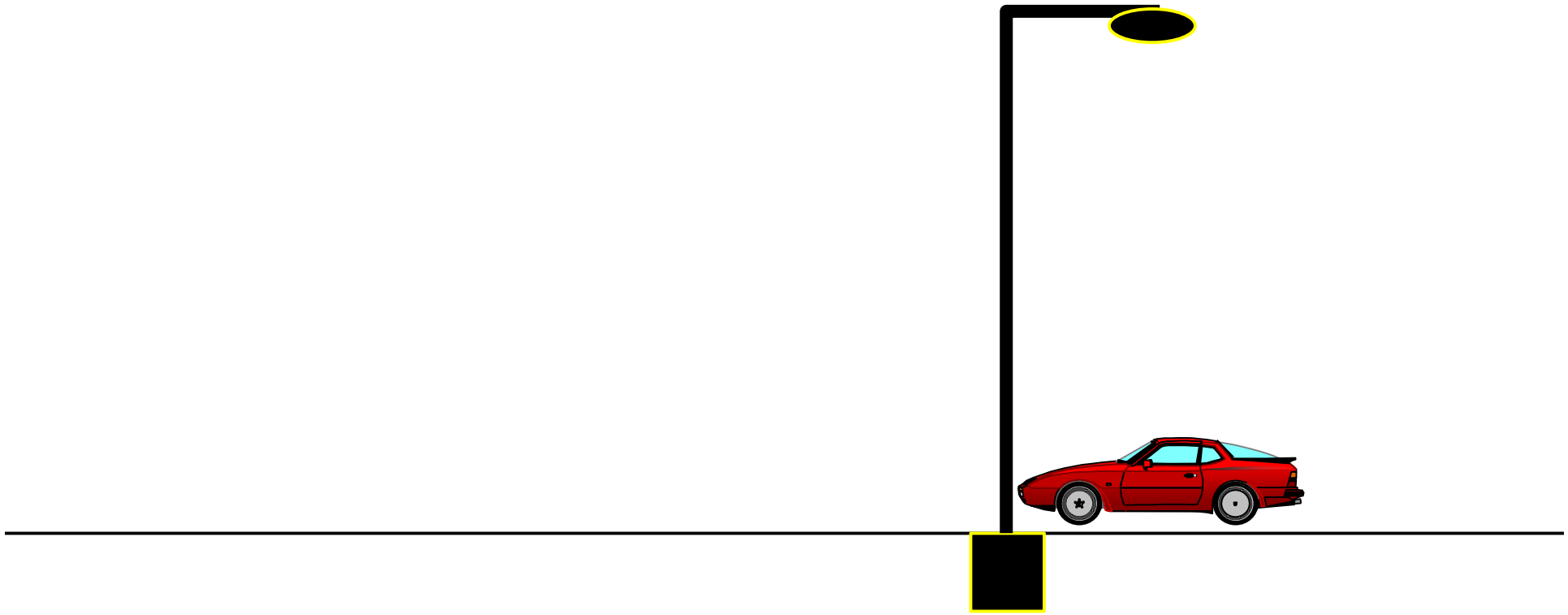
Impact Absorbing Pole

Lower speed areas

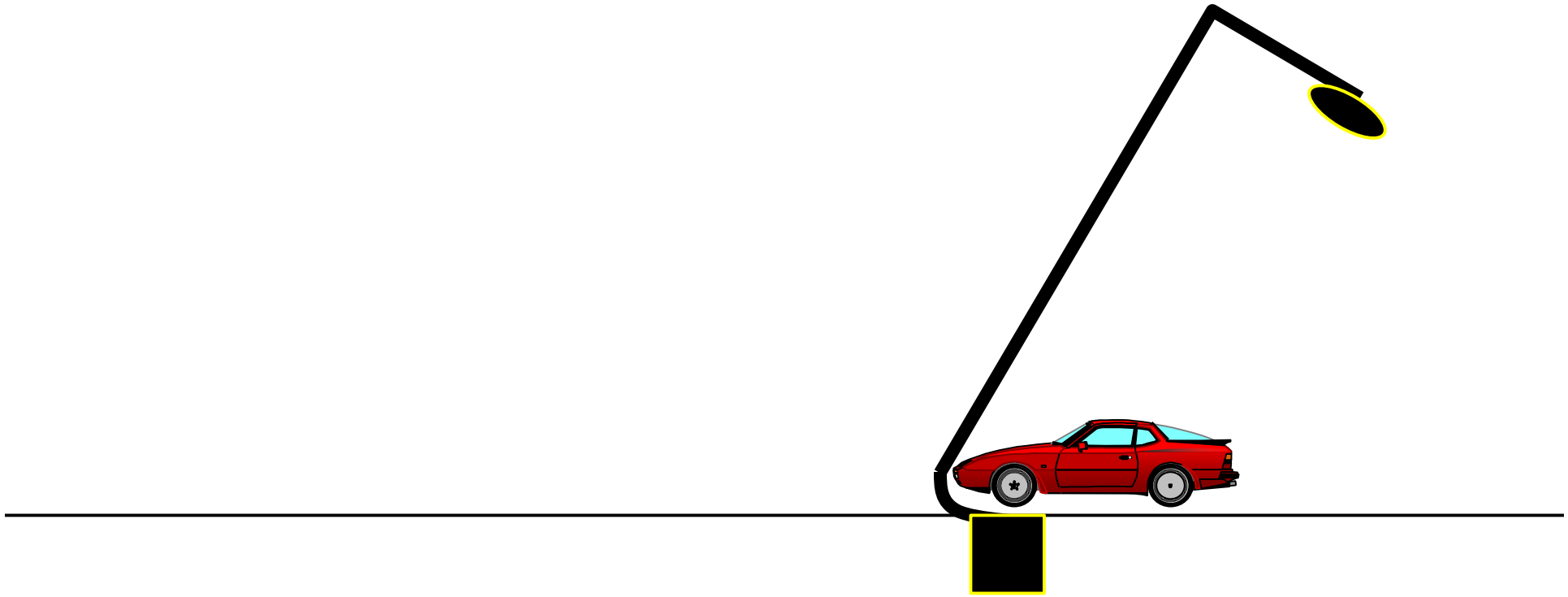
More pedestrians and parking



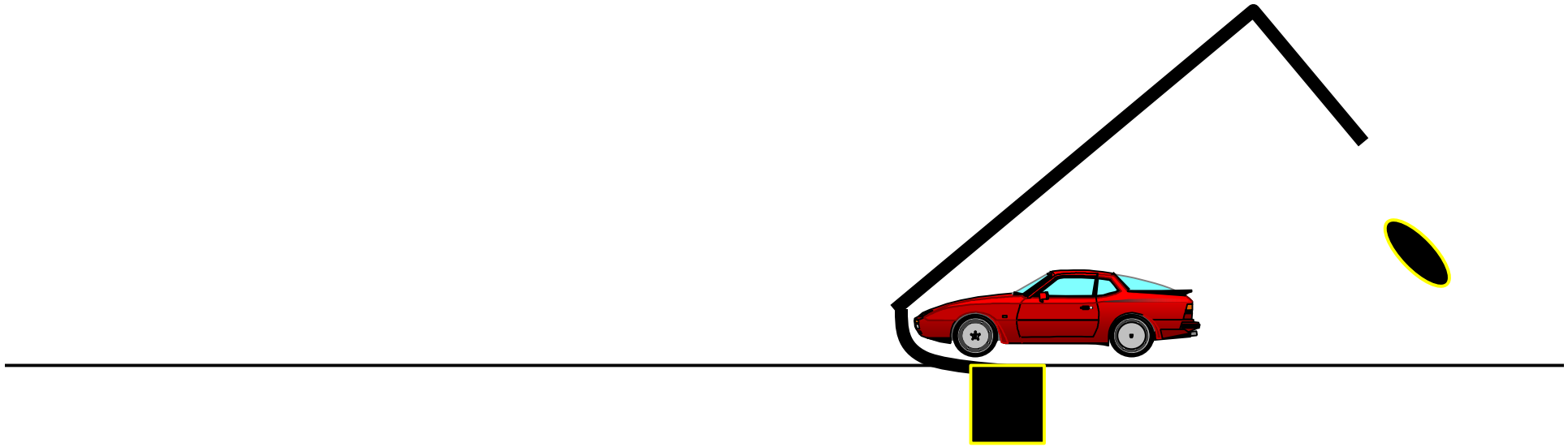
Impact Absorbing Pole



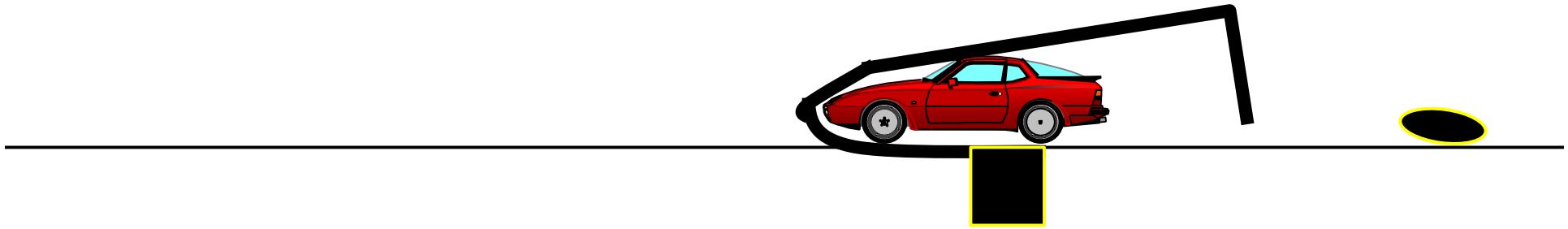
Impact Absorbing Pole



Impact Absorbing Pole

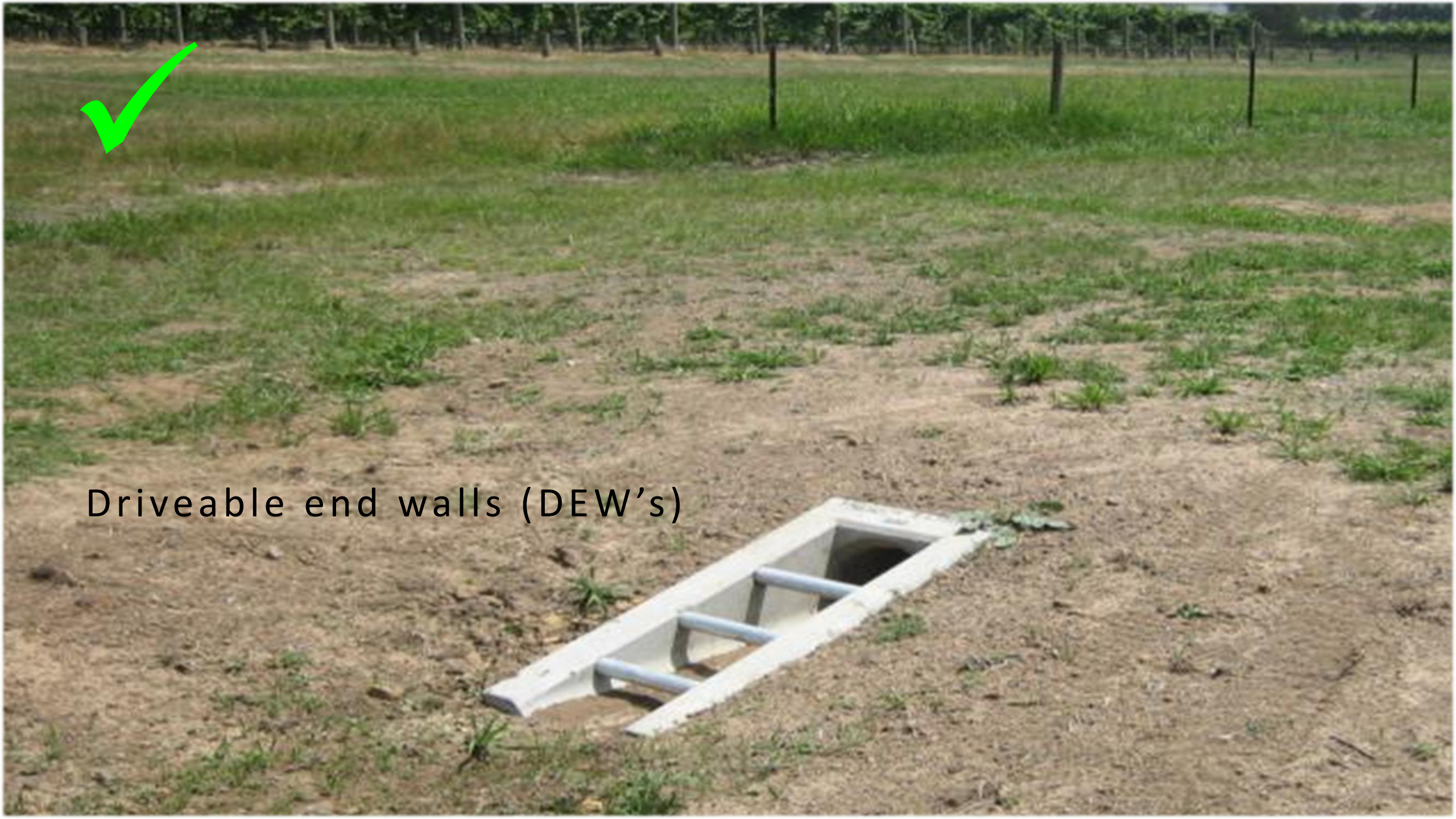


Impact Absorbing Pole



Impact Absorbing Pole

Cross culverts and side drainage pipes are hazards


Driveable end walls (DEW’s)


Driveable end walls (DEW's)

Driveable end walls

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 constrained …..but 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

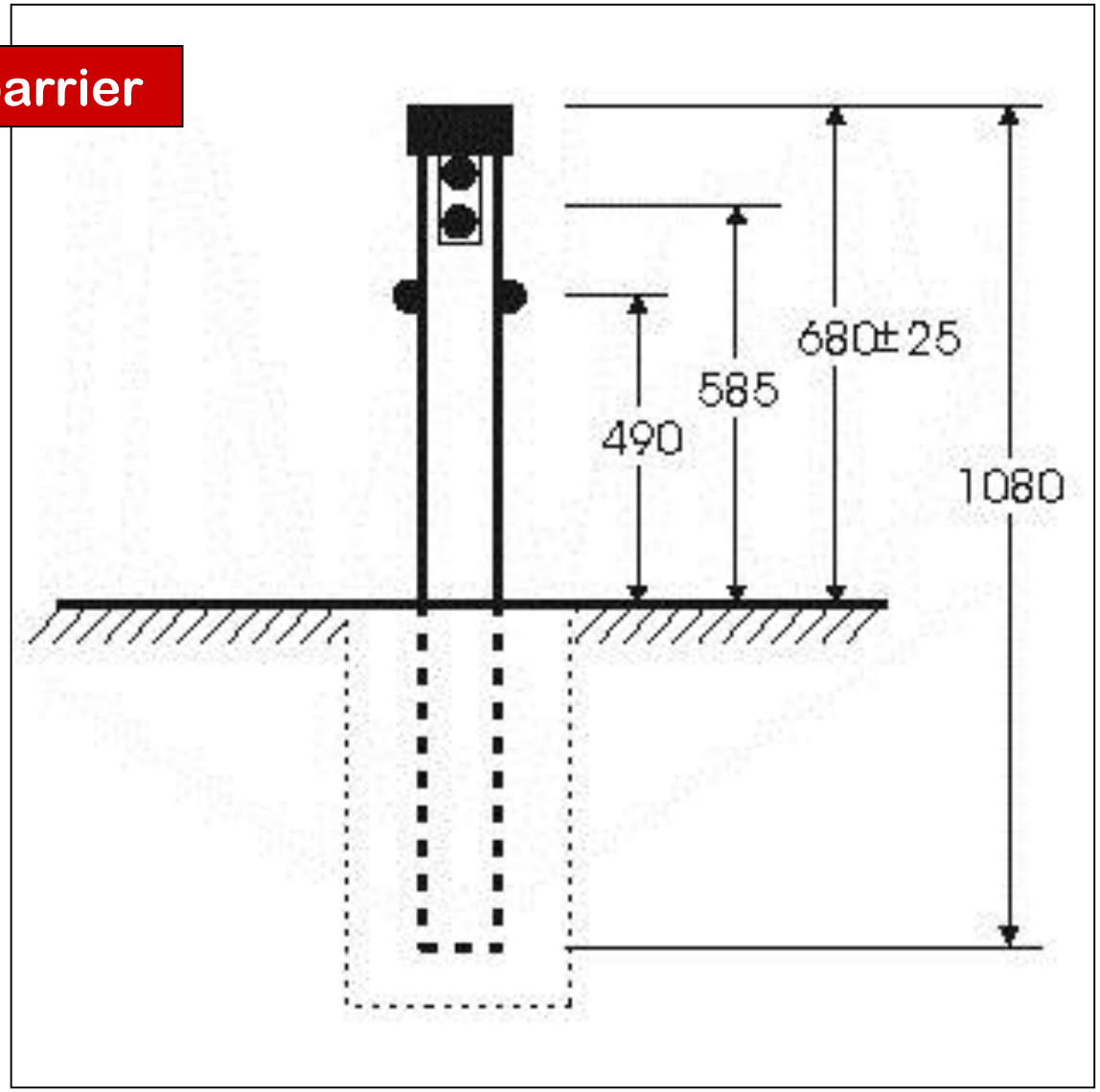
- Flexible barriers
- Semi-rigid barriers
- Rigid barriers

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


BRIFEN USA INC.
WIRE ROPE SAFETY FENCE
TL-4 Crash Testing

Flexfence Wire Rope Safety Barrier


Filmed under test conditions

Ezy-Guard

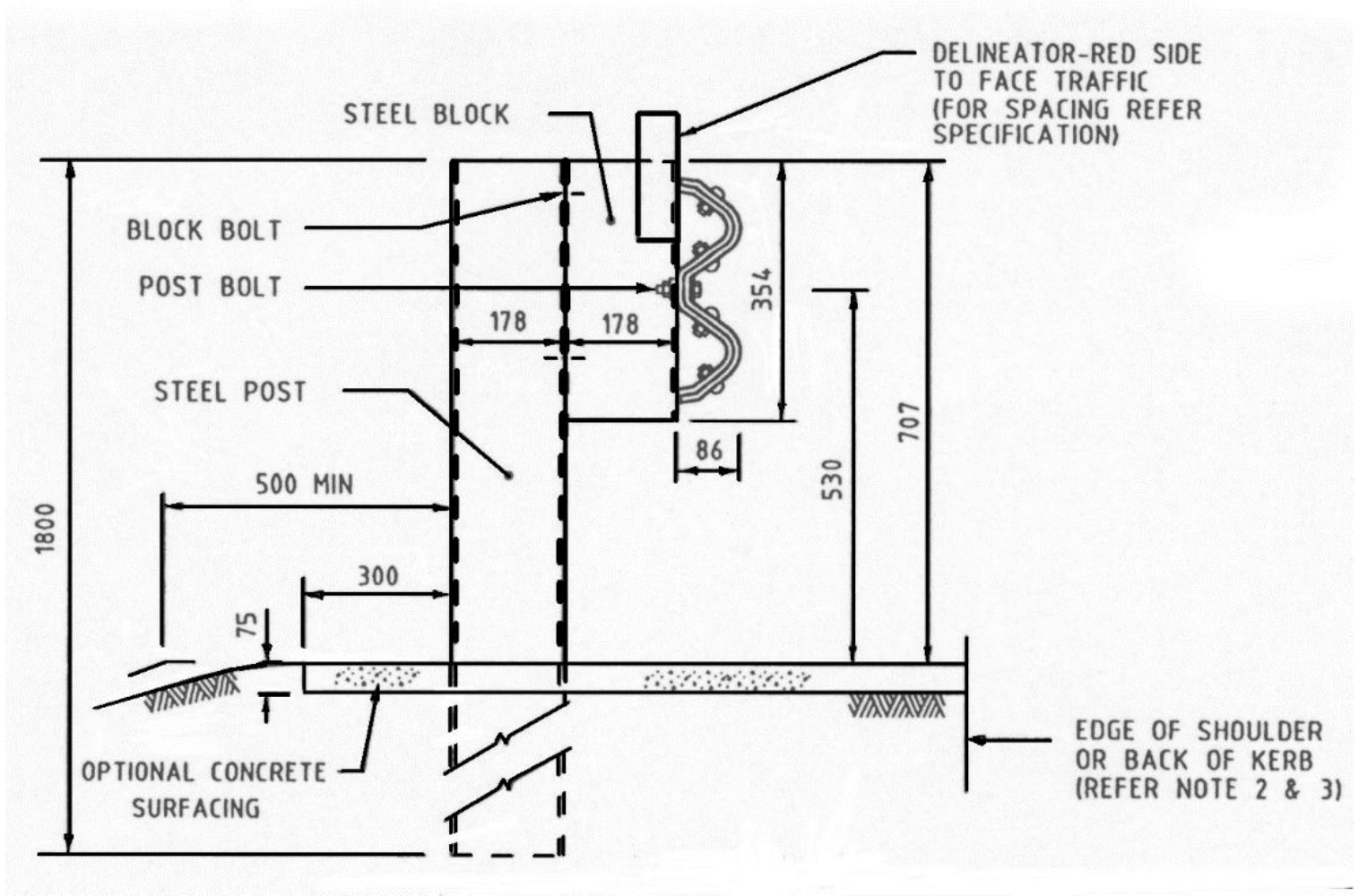
Ezy-Guard

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 - 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!)

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

...turn away now

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

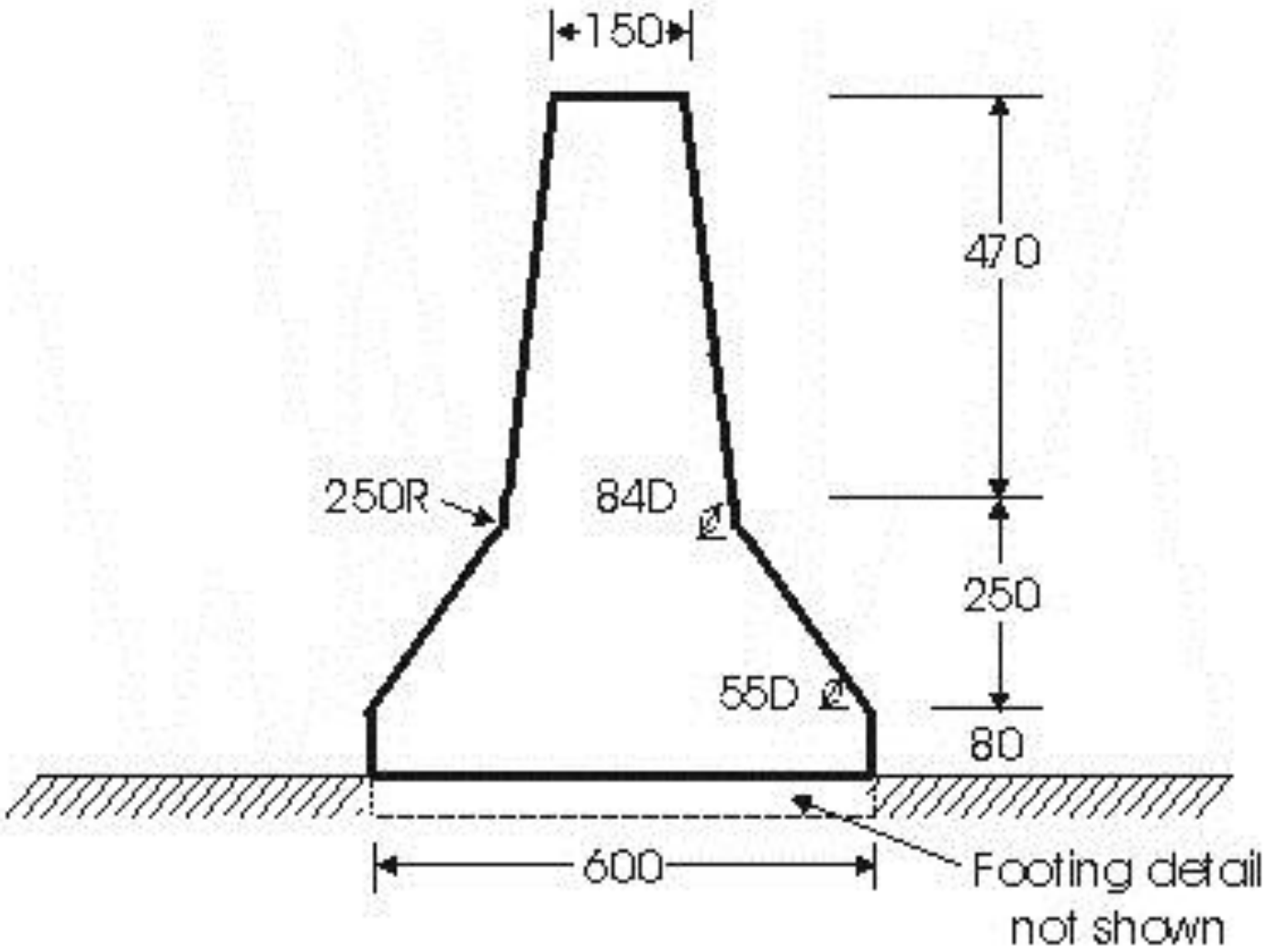
- Concrete
- Several profiles
- No deflection
- Minimal repairs
- Cast in place, or set in place
- End treatments are vital

Rigid barriers

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

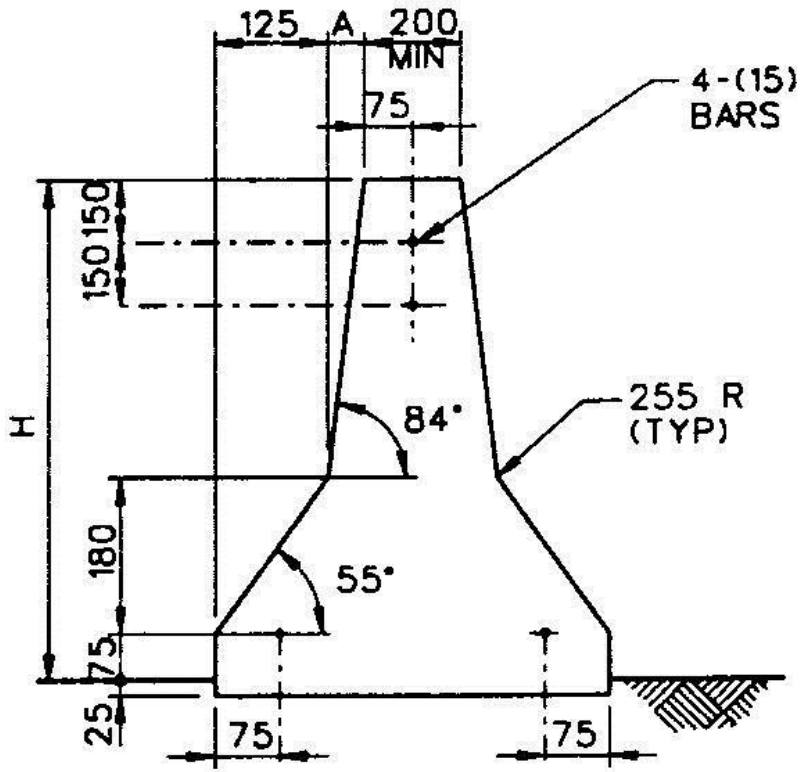
New Jersey Barrier

Rigid barrier



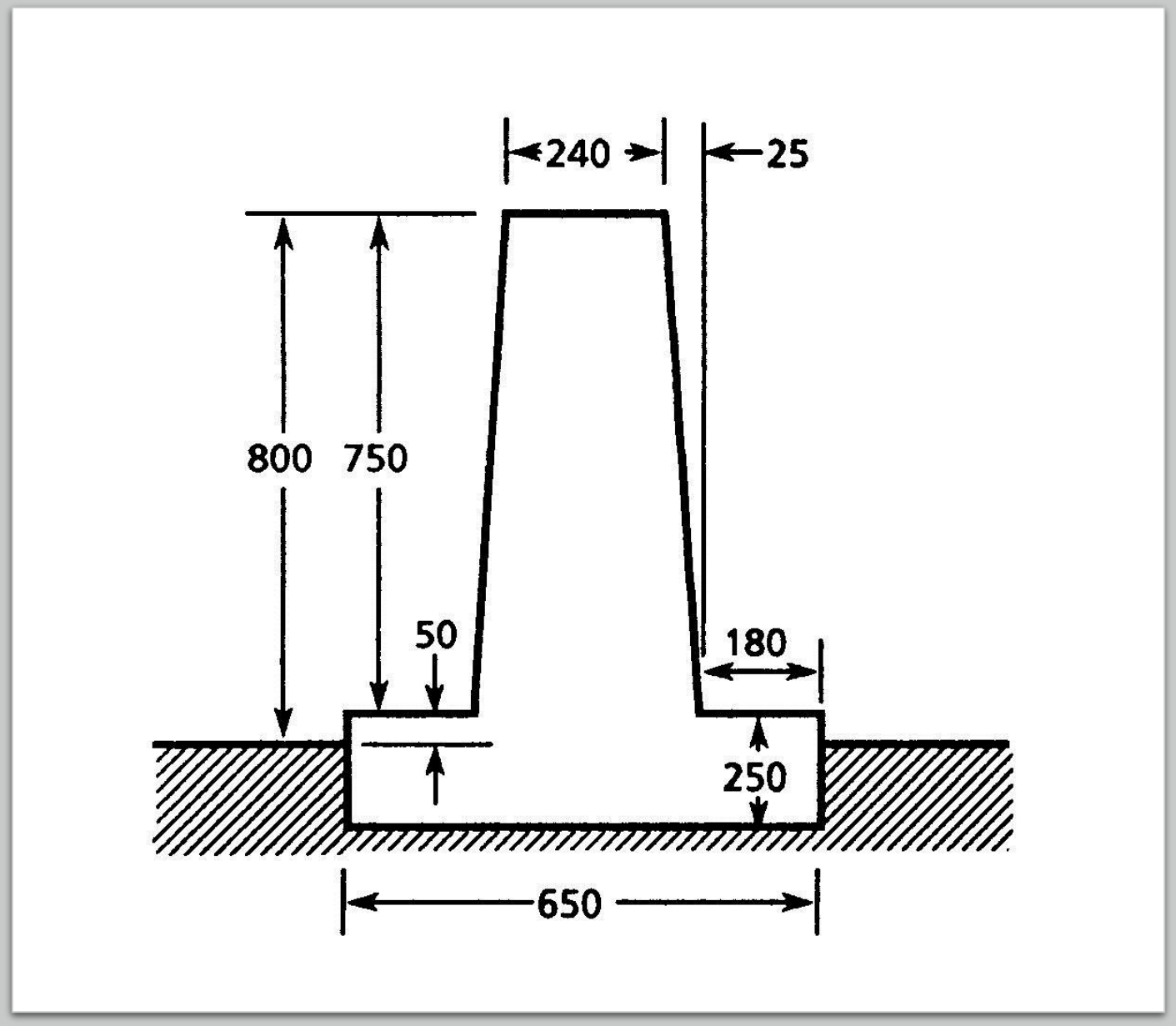
Rigid barrier

F Profile Barrier



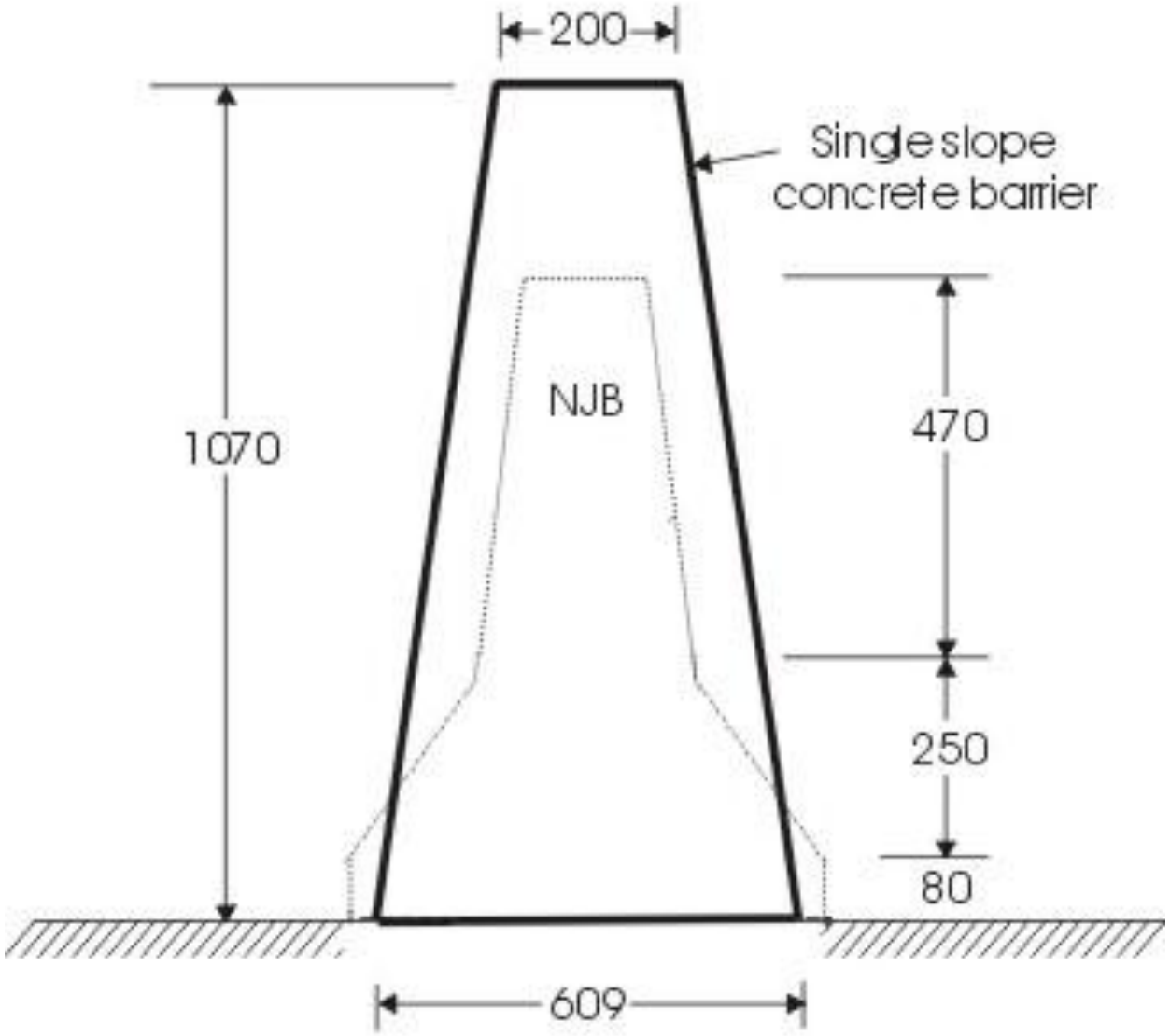
Rigid barrier

Vertical Face Barrier



Rigid barrier

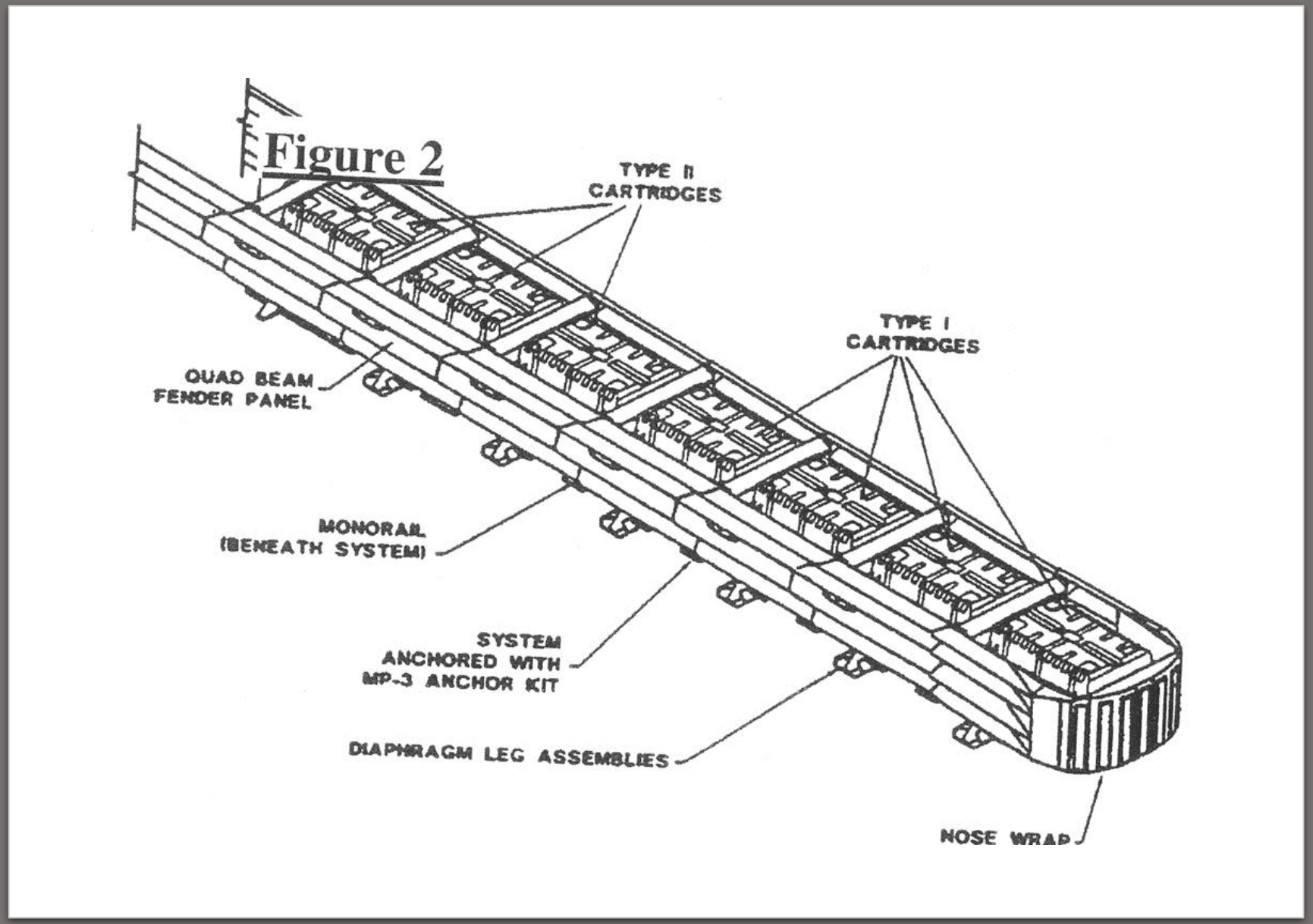
Constant (single) Slope Barrier



Constant (single) slope barrier

Safety roller barrier

Rock gabion basket – hair-pin bend, Nepal



Impact Attenuator


REDUCE
SPEED
NOW
SLOW
EXIT 15
Rochor Rd

Impact Attenuator

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

Raptor

THE THREE I’s

- IDENTIFY
- INVESTIGATE
- IMPLEMENT

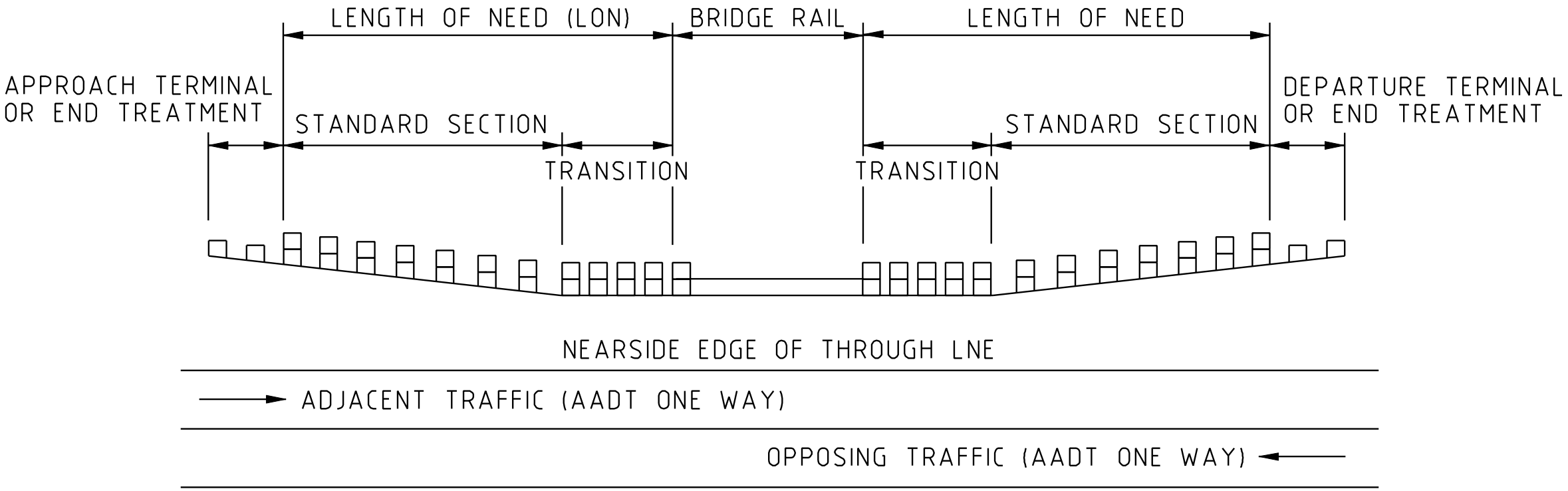
Nine things to look for when checking barriers

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

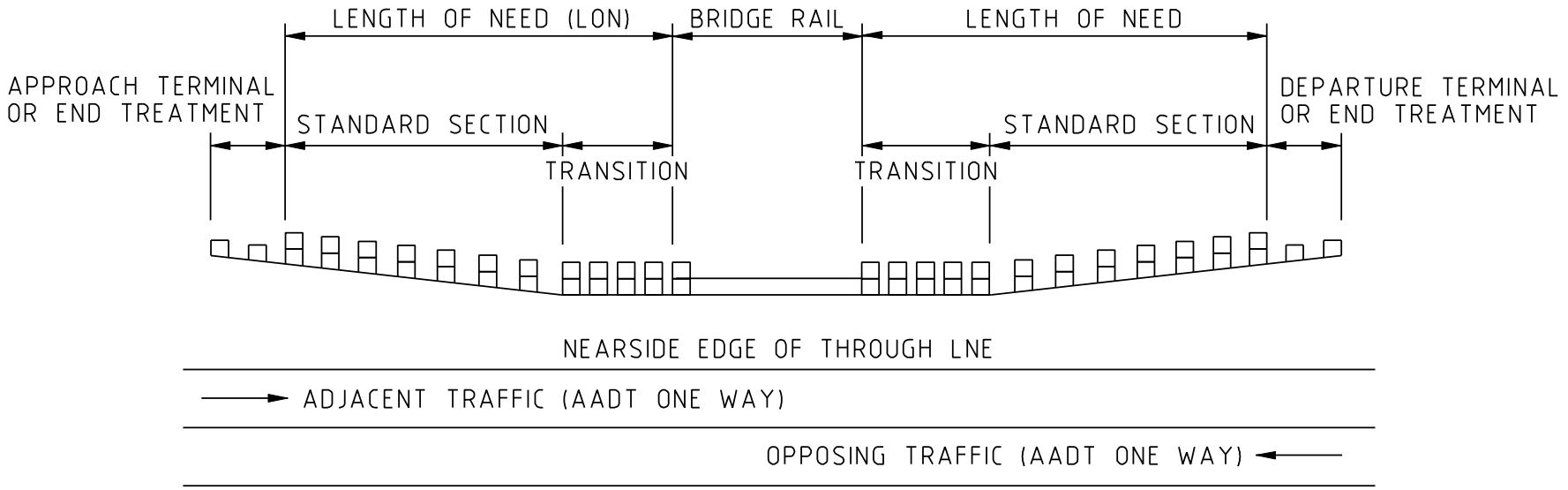
- Length of need
- Barrier length
- Offset to the barrier
- Deflection
- Proximity to kerbs (avoid vaulting)
- Stiffen (prevent pocketing)
- Mounting height (watch for vaulting)
- End treatments (prevent spearing)
- Working Width (snagging)

1 Length of need

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

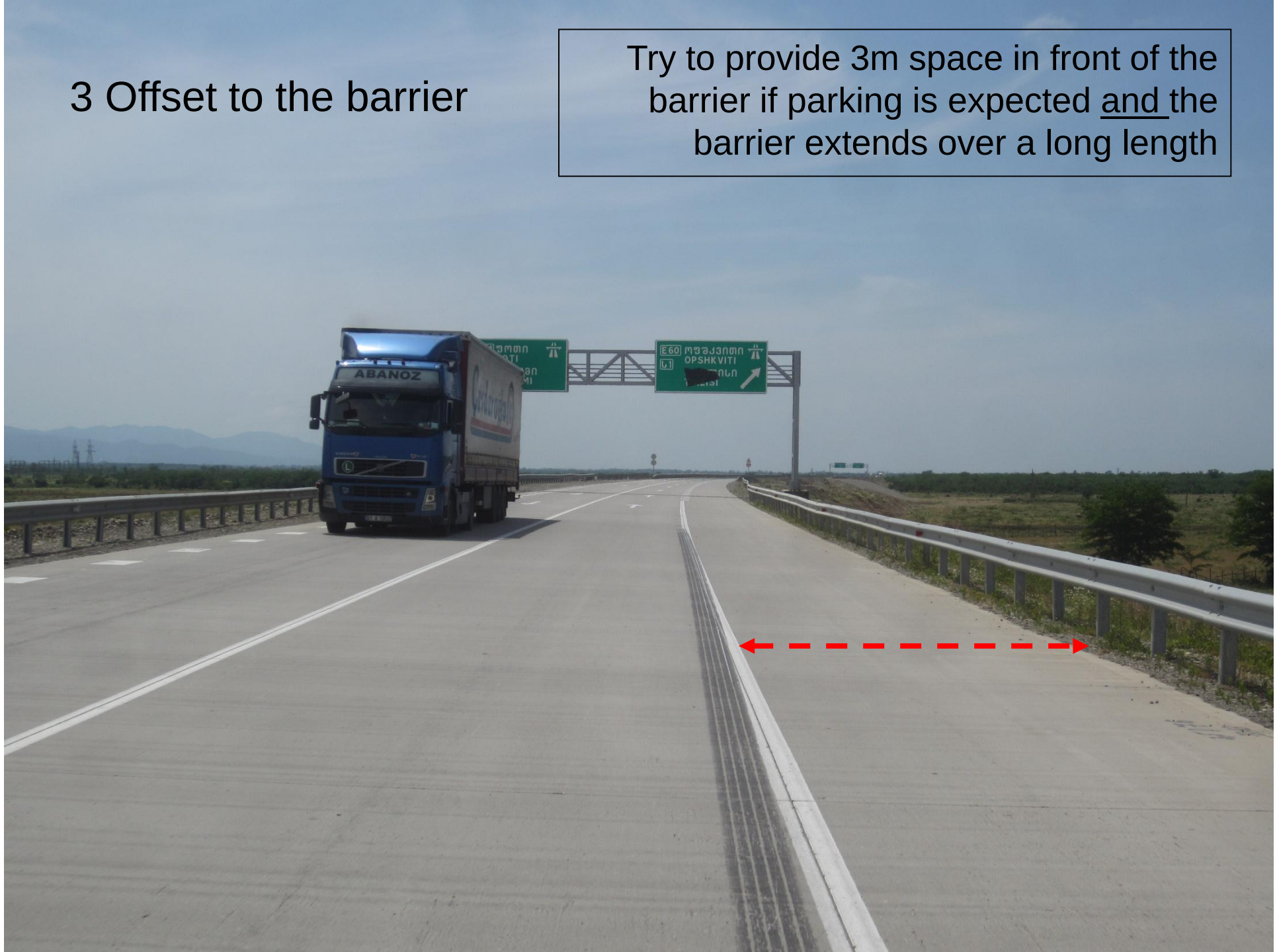
The LON (nearside) plus the LON (offside) plus the length of the hazard, plus the end terminals

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.


/03/2016 12:35:44

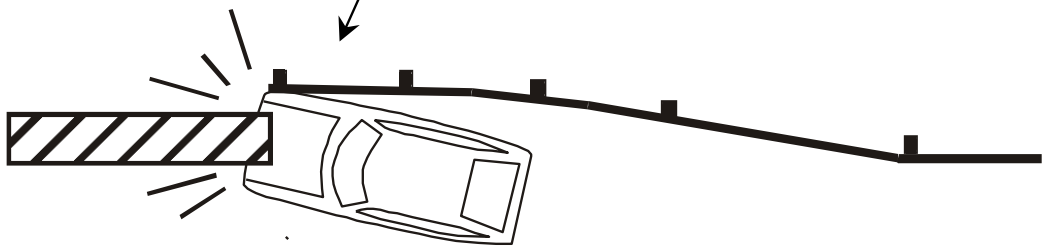
6 Avoid “pocketing”

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)

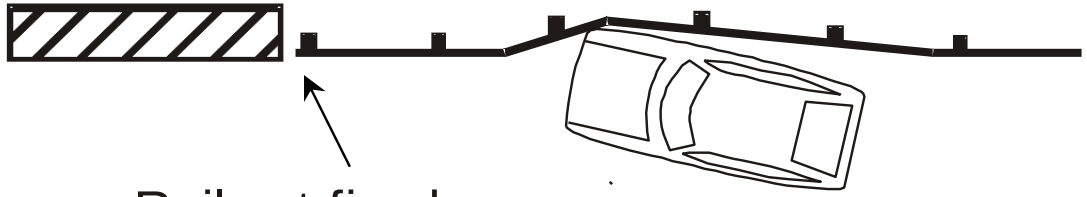

Is this bridge parapet “safe”?

“Pocketing”

Posts and guardrail deflect and leave the parapet exposed

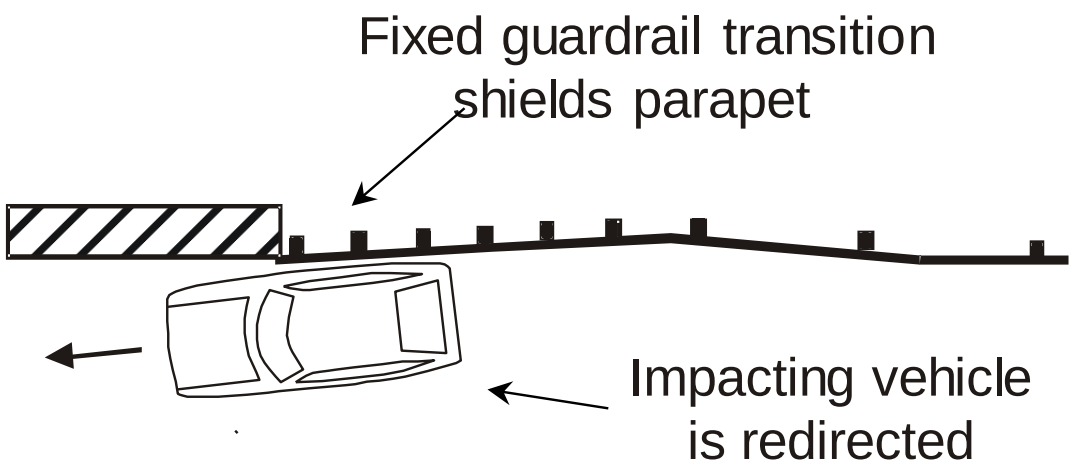


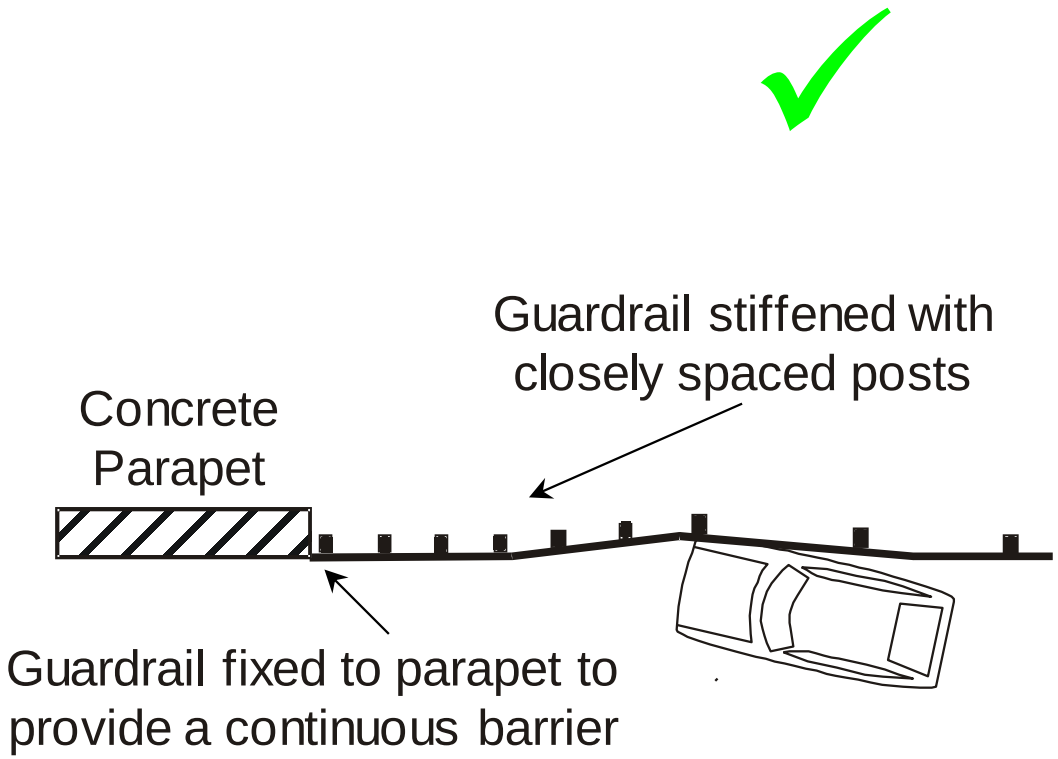
Concrete Parapet



Rail not fixed to parapet

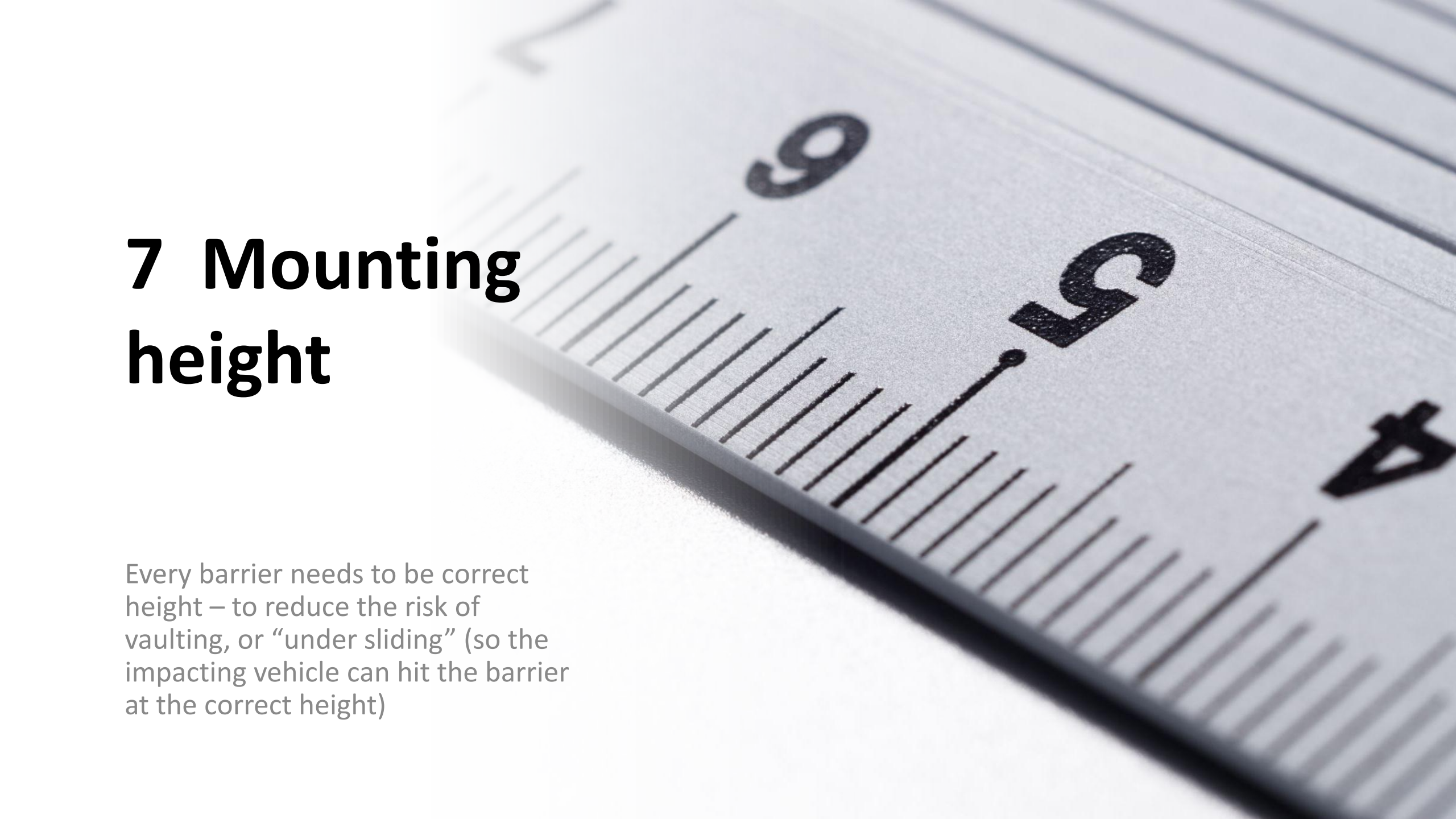
No “pocketing”





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

Semi-rigid barriers


ROAD SAFETY

NEAR THING: CFA member Andrew Day and other emergency workers at the accident scene where a guard rail speared through a car narrowly missing the driver. Pictures: **Andrew Kelly**

‘Miracle’ escape for crashed driver

End treatments are necessary to avoid penetration into the vehicle

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.


رؤية VISION 2030
المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA
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EXIT
مخرج
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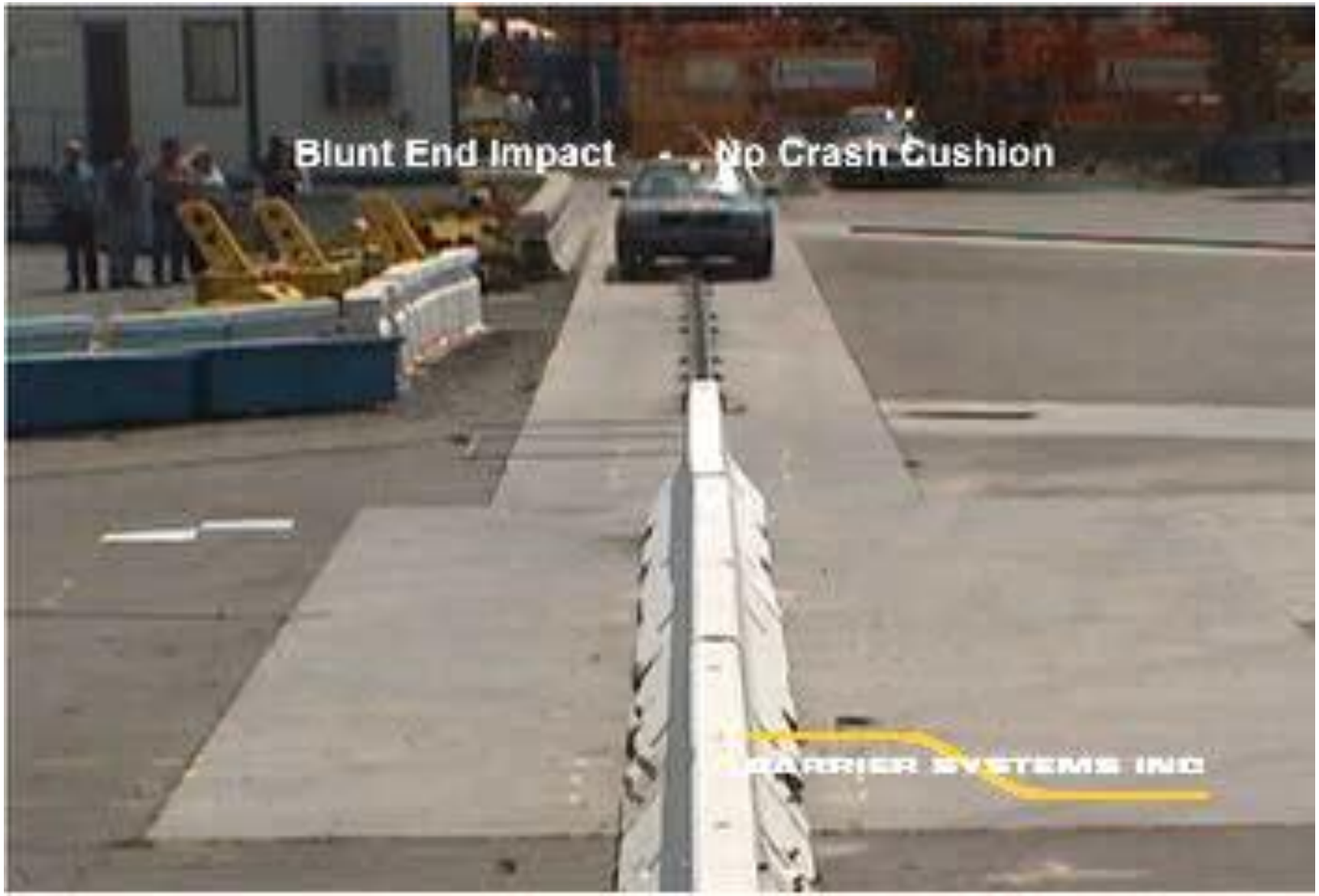
MAKKAH
مدخل خاص
PRIVATE
ENTRANCE
مطار الملك عبد العزيز الدولي
KING ABDULAZIZ INT. AIRPORT

Every barrier needs safe, effective terminals – on both ends


Safe, effective terminals

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


Blunt End Impact
No Crash Cushion
BARRIER SYSTEMS INC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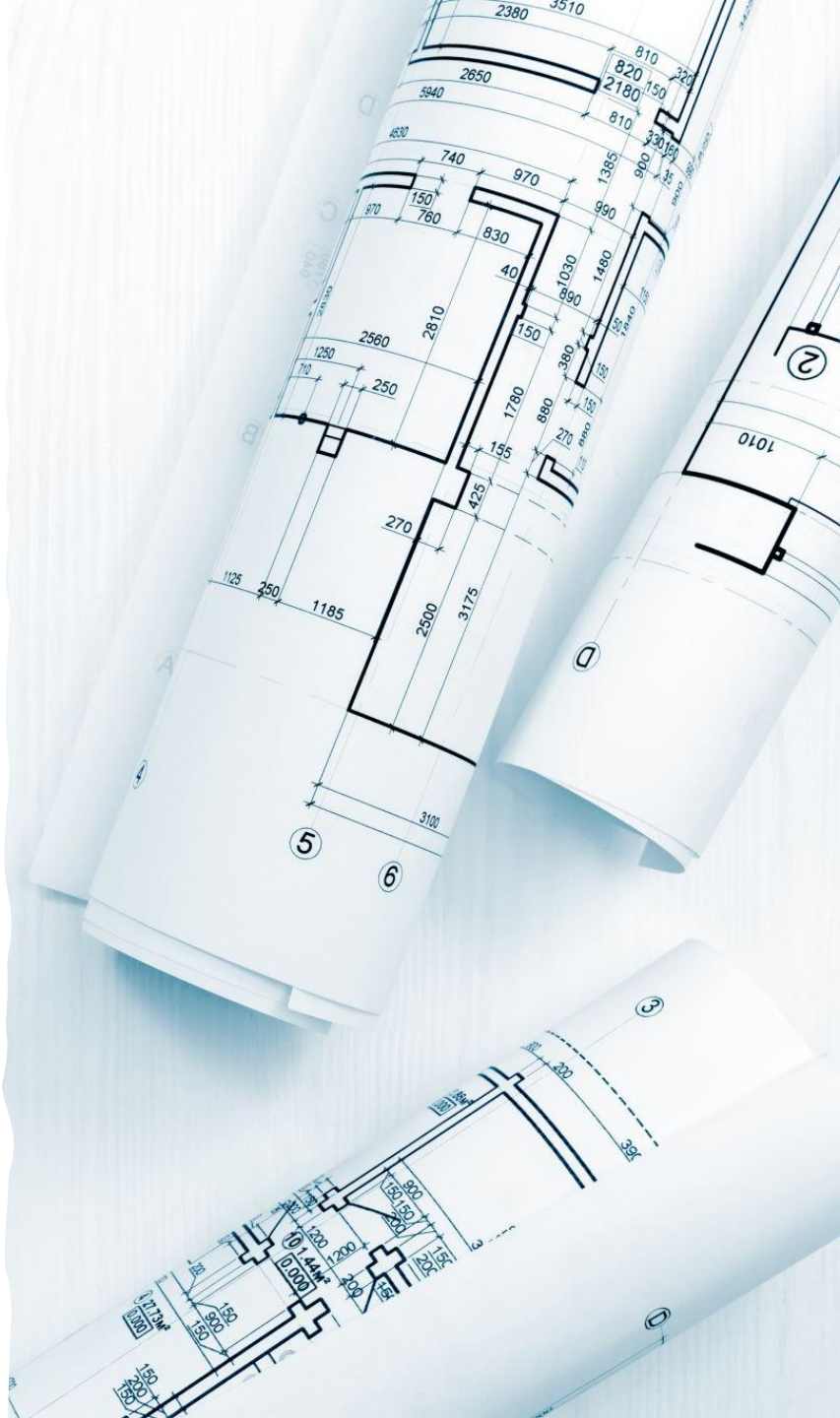
REDUCE SPEED NOW
SLOW
EXIT 15
Rochor Rd
Impact Attenuator

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

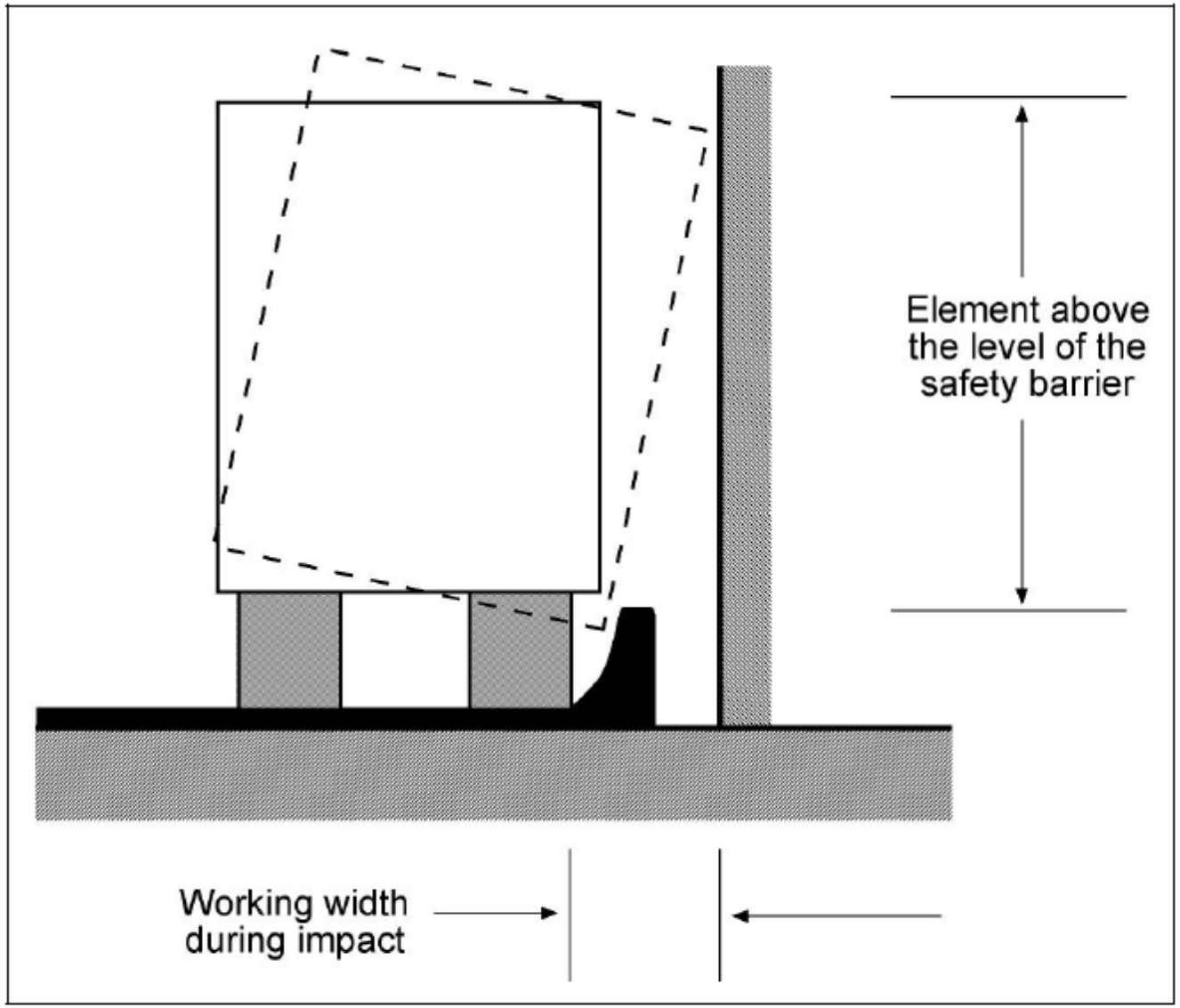

Element above the level of the safety barrier
Working width during impact

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?