"Practical Road Safety Engineering" online workshop

# Module 7 – Managing road safety audit

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Welcome back everyone

"Practical Road Safety Engineering" online workshop

MODULE 7 – MANAGING ROAD SAFETY AUDIT

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| Participant | Question |
|---|---|
| Can bridge projects with approaches also be subjected to road safety audit & In India approximately 17% accidents takes lace due to Pot Holes so as an auditor can we not recommend the maintenance of roads by filling Pot Holes | SUBHASH NIGAM |

Bridge projects (with or without approach roads) can be subjected to a road safety audit. In PNG I audited 9 bridges scattered across 200km of national highways.

Pot holes – mmm – I am always coy when I read that any crash is due to one individual factor. Police look for someone or something to blame and they sometimes overlook the real factors. So I would question this 17% figure.

In some audits it may be reasonable to recommend maintenance but we will usually be doing design audits. Not road safety inspections where you may see the pot holes.

And what Project manager doesn't know about the need for maintenance?

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| Participant | Question |
|---|---|
| Can roundabouts be oval shape (not perfect circle)? Also is there any other shapes? | Lohitha Sedara Senarath 1 |

Roundabouts can be (almost) any shape – but they must provide adequate geometric deflection on all the approaches.

That is why most roundabouts have circular central islands. Egg-a-bouts are fine too.

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| Participant | Question |
|---|---|
| Can the sorting of different types of vehicles according to its class be part of doing road safety audit? or is it necessary to include that when we are doing road safety audit during preliminary design? thank you. | MARVIN G. TERRADO |

Mmmm – I'm unsure what you are really asking. Sorry

Road safety audit is about looking for potential road safety concerns in a design drawing.

It involves finding problems.

Counting vehicles is not really a part of an audit……but when we go on a site inspection we should be looking at the traffic (compositions, volume, speeds) as well as topography etc

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| Participant | Question |
|---|---|
| Will it not be effective to introduce mandatory provision of Road Safety Audit in Contract /Concession Agreements, to make developers fully responsible for road safety ? | Sh. Ashok Kumar Pareek |

Absolutely – but I understand that RSA's are often required in such contracts already? Yes?

The real challenge is in making the RSA's effective!

Good auditors only emerge when there is a solid road safety engineering profession

Do you have enough road safety engineers in India?

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| | |
|---|---|
| Sometimes provision of roundabout itself is no guarantee that accidents/crash would not happen there. I happened to be living in Suburban Sydney (near Parramatta) around year 2000 and once I was nearly hit by an overspeeding car (reckless yound driver, probably drunk) at a roundabout near Parramatta. I was riding a bicycle at that time.<br><br>So, sometimes reckless car driver or poor road user behaviour can also lead to crash at roundabout. Do you agree? | Debashis Puzari<br>Assam, India |

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- While the human is the major contributor to crashes, he is not the only contributor. The road also plays a role - and as engineers we have a responsibility to make "the road as safe as practical". Vehicles play a role - but not as much as some people think. Overloading is an issue but brake failures and tyre blow outs (while they do happen) are perhaps an excuse for some crash types.

- So this workshop is all about how engineers need to work to make sure the road is put into road safety. The workshop does not deny that humans need safety awareness, strict enforcement, competent driver licensing etc.

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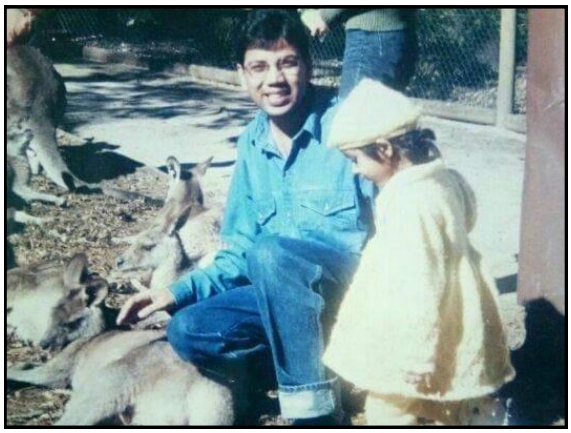

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## Feedback on your blackspot homework

Almost 200 reports received. Great work all!

Enthusiasm to eliminate a hazardous location is an essential first step

Marking is on-going – nearly done!

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We wanted you to :

- Look for patterns in the crashes
- Think about treatments that WILL WORK (eg rumble strips, speed breakers, and very low speed limits are not effective, especially in rural areas. WRSB has no impact on pedestrian collisions)
- Move away from some of your "traditional thinking"
- Consider all the options – and select the one(s) that will likely work the best
- Be logical – and if you can develop a BCR that's a bonus.
- PS It's not easy investigating a blackspot in a country you may never have been to!

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Homework Option 1 (120 reports)

Urban arterial pedestrian collision problem. 14 crashes in past 3 years. Mainly night time.

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| CRASH NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 12/3 | 5/5 | 11/10 | 29/11 | 20/1 | 28/3 | 1/4 | 5/9 | 8/12 | 31/12 | 2/2 | 10/3 | 5/6 | 7/9 |
| DAY OF WEEK | SUN | FRI | WED | WED | SAT | WED | SUN | WED | SAT | MON | MON | SUN | WED | SAT |
| TIME OF DAY | 01.15 | 22.30 | 19.20 | 17.50 | 11.10 | 20.55 | 18.30 | 23.00 | 14.40 | 04.00 | 06.45 | 23.30 | ? | 20.30 |
| SEVERITY | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 3 | 1 | 3 | 1 | 2 | 2 |
| LIGHT CONDITION | | | | | | | | | | | | | ? | |
| ROAD CONDITION | WET | DRY | DRY | DRY | DRY | DRY | WET | DRY | WET | DRY | DRY | DRY | ? | DRY |
| CRASH TYPE | 003 | 003 | 001 | 303 | 001 | 102 | 207 | 002 | 102 | 004 | 001 | 502 | ? | 301 |
| VEHICLE 1 | CAR | CAR | BUS | BUS | CAR | CAR | M/C | CAR | CAR | CAR | M/C | M/C | PED | CAR |
| VEHICLE 2 | PED | PED | PED | TRUCK | PED | BIKE | CAR | PED | M/C | PED | PED | | ? | CAR |
| VEHICLE 3 | | | | CAR | | | | | | | | | | CAR |
| DIRECTION VEH. 1 | E | E | E | W | W | E | W | W | E | E | W | E | ? | E |
| DIRECTION VEH.2 | N | N | S | W | S | S | W | N | NE | N | S | N | ? | ? |
| DIRECTION VEH.3 | | | | W | | | | | | | | | | W |
| OBSERVATIONS | ALC | ALC | SPEED | | | | | ALC & SPEED | | | | SPEED | | U TURN |

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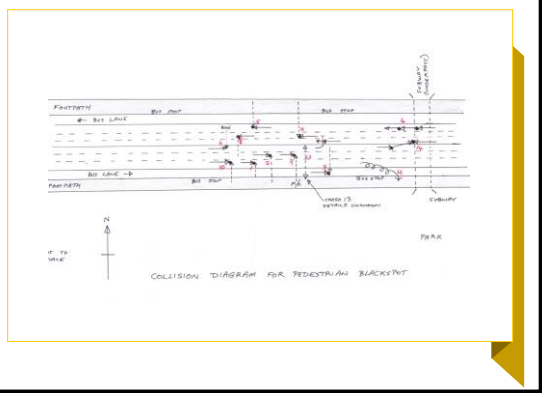


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Common suggestions from participants:

- ❖ Improve the underpass
- ❖ Install fencing to block pedestrian access to the road
- ❖ Street lighting (7 of 8 ped crashes were at night)
- ❖ Pedestrian refuge
- ❖ New signals (PUFFIN)
- ❖ BUT – WRSB will have no usefulness and will cost money

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Phillip Jordan suggests a two-stage approach; Stage 1 will commence as soon as approvals and funding will permit. Stage 2 in one year

Stage One:

- Improve the underpass by constructing ramps (for the disabled) and by improving the lighting (outside and inside the underpass).
- Construct a long central refuge where pedestrians cross the road between the bus stops. A 2m wide refuge is achievable by reducing each traffic lane to a uniform width of 3.5m. A 20m long refuge will be able to store 500+ pedestrians per hour.
- Install twelve new streetlights to enhance the area after dark.
- Begin regular Police enforcement of speeding.
- Monitor closely after these works to assess if Stage Two is needed.
- CRF = 50% (for the pedestrian refuge)

Stage Two:

- A PUFFIN crossing will be designed and installed in Year 2 (when more funds are available) to give pedestrians the time separation from motor vehicles they need on this wide arterial road.
- No additional CRF – as the whole package is calculated as one and costs are split over 2 years

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Stage 1 and 2 BCR = Benefits 50% of ped crashes (67% of fatal ped crashes)
Use 50% of 8 crashes = 4 crashes in 3 years, so about 8 x 4 = 32 crashes prevented in 25 year life of refuge.
One crash = $150,000

Benefits = 32 x $150,000 = $4,800,000

Costs estimated $300,000

BCR = 4,800,000/300,000 = 16

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| CRASH NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 12/3 | ? | 11/7 | 29/1 | 28/3 | 1/4 | 5/9 | 8/2 | 31/4 | ? | 10/8 | 7/9 |
| DAY OF WEEK | SUN | FRI | WED | WED | WED | SUN | WED | SAT | MON | | SUN | SAT |
| TIME OF DAY | 01.00 | ? | 19.30 | 17.50 | ? | 18.30 | 22.00 | 14.40 | 04.00 | ? | 23.30 | 20.30 |
| SEVERITY | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 |
| LIGHT CONDITION | | | | | | | | | | | | |
| ROAD CONDITION | WET | DRY | DRY | DRY | DRY | WET | DRY | WET | DRY | DRY | DRY | DRY |
| CRASH TYPE | 202 | 202 | 301 | 301 | 202 | 202 | 002 | 202 | 301 | 701 | 202 | 202 |
| VEHICLE 1 | TRUCK | CAR | BUS | BUS | CAR | M/C | PED | TRUCK | CAR | TRUCK | M/C | TRUCK |
| VEHICLE 2 | BUS | TRUCK | TRUCK | TRUCK | M/C | BUS | CAR | M/C | CAR | | TRUCK | CAR |
| VEHICLE 3 | | | | | | | | | | | | |
| DIRECTION VEH. 1 | S | S | S | S | S | S | E | S | N | N | E | E |
| DIRECTION VEH.2 | N | N | S | S | N | N | N | N | N | | N | ? |
| DIRECTION VEH.3 | | | | | | | | | | | | W |
| OBSERVATIONS | | | SPEED | SPEED | | | | | | | SPEED | |

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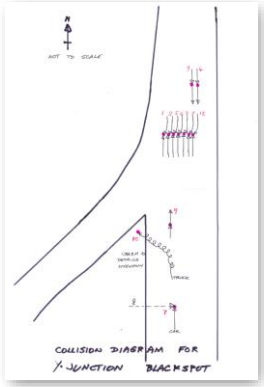


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Common suggestions:

- Signs – all sorts (but a sign warning this is a blackspot will NOT work)
- Street lighting (7 of 8 right turn against crashes were at night)
- Channelization
- Install traffic signals (questionable in a rural area)
- Rumble strips, flashing yellow signal (remember that the over use of such treatments leads to user disregard – and disrespect).
- Try to fix the problem – do not simply warn of it

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**PHILLIP JORDAN RECOMMENDED COUNTERMEASURES:**

**Stage 1**

Install diagrammatic advanced direction signs on all three approaches informing road users of the destinations in each direction (See photograph of a typical example below).
Install oversized (900mm) "Intersection" warning signs on both approaches of NH 13.
Remove other existing signs from the intersection.
Install a centre line and edge lines on both highways.
Install duplicate Give Way signs and line marking facing SH 25 traffic (squared up with NH 13 to create a T junction as much as the road reservation will permit without land acquisition).
Install an advanced warning sign "Give Way Ahead" on SH 25.
Seal all shoulders through the intersection to at least 1.5m width.

**Stage 2**

Install street lighting (one on each approach) at the intersection.
Square up SH25 fully to intersect with NH13 at a T-junction.
Construct channelization on NH 13 to provide physical separation of NH13 traffic though the junction, including a sheltered right turn lane for traffic turning from NH13 to SH 25. (See a typical layout below).

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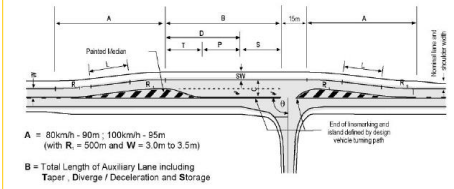


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BCR = Benefits 85% of all crashes due to removal of Y junction
Use 85% of 12 crashes = 10 crashes in 3 years, so about 8 x 10 = 80 crashes prevented in 25 year life of new T junction.
One crash = $75,000

Benefits = 80 x $75,000 = $6,000,000

Costs estimated $1,200,000

BCR = 6,000,000/1,200,000 = 5

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## Module 7 – Managing road safety audit

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How can you put road safety audit to **work in your road authority?**

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## Managing the road safety audit process

1. Getting it started in your organisation
2. A national RSA policy
3. Accreditation of auditors
4. ToR's for audits
5. What to do with an audit report.

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## 1 Getting it started in your organisation

- Have your CEO make a formal commitment to improving road safety. Empowerment is critical to creating a "safety culture" in your road authority.
- Develop a Road Safety Plan. Include a blackspot program as well as the road safety audit process.
- Nominate someone to "champion" the cause of road safety audit in your organisation.
- Hold a meeting of senior technical staff to discuss and address the important road safety audit issues that will arise in your organisation.
- Develop an audit policy and a set of basic audit practices which meet your organization's needs.

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Points to discuss:

- How will the organisation get adequate road safety audit skills and resources?
- Designers may initially resist having their work audited.
- How much training is required? (Managers, designers, potential auditors)
- What road projects are to be audited in your organisation?
- How will road safety audit be incorporated into design and construction contracts?
- At what design stages will audits be conducted?
- Who will be conducting audits? Who manages the national register of auditors? Who can give you advice on these issues?
- How will audit recommendations be dealt with? Who decides to accept or reject the recommendations?
- How will audit findings be used to improve future designs?

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- Get started.
- Consider engaging a team of experienced road safety auditors to undertake pilot projects of your road designs.
- Follow your agreed road safety audit policy.
- Get feedback from your auditors, your designers and your managers and then modify your audit policy and the audit process to best suit your authority as experience grows.
- Be prepared for some mistakes but learn from those mistakes so that the road safety audit process can grow in your organisation.

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- Let your senior executives know how the audit process is progressing in your organisation. Give them examples of where your road users have benefited because of the road safety improvements generated through the audit process.
- Let them know how staff members are learning new skills as a result of the process.
- Keep it going! Even when road safety audit becomes established in your organisation do not believe that it will continue automatically. Monitor the quality and the quantity of audit reports. Maintain a training and awareness program.
- Ensure your "champion" of road safety audit is empowered to promote the process with continued energy and passion. Road safety audit needs to be used widely in your authority well into the future. The safety of your road users demands it.

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## 2 A national RSA policy

Suggestion for a national RSA Policy

| Audit | Tollways / Expressways | National Highways | Other Highways | Major Rural Roads | Urban Arterial Roads | Local Streets & Village Roads |
|---|---|---|---|---|---|---|
| Planning | ✓ | ✓ | Optional | Optional | Optional | N/A |
| Preliminary Design | ✓ | ✓ | ✓ | Optional | ✓ | Optional |
| Detailed Design | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Construction | ✓ | ✓ | ✓ | Optional | Optional | Optional |
| Pre-opening | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Safety Inspections of Existing Roads | According to local policy and resources | | | | | |
| No. of Audits | 4 | 4 | Minimum 3 | Minimum 2 | Minimum 2 | Minimum 2 |

What do you think of this?

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## 3 The national register of road safety auditors is administered by the Ministry of Transport.

Access to the register is via an agreed website

To be registered as a Senior Road Safety Auditor an applicant should:

- have completed an approved road safety audit training workshop, and
- have a minimum of two years practical experience in a road or road safety related field, and
- have completed at least five road safety audits under the guidance of a Senior Road Safety Auditor. At least three of the five audits must be at a design stage.

A Road Safety Auditor should:

- have completed an approved road safety audit training workshop, and
- have a minimum of two years practical experience in a road or road safety related field.

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## 4 Draft ToR's for audits

**a. Background**

- The [insert name of road authority] has developed a proposal to [insert a brief description of the type and location of the proposal] in order to provide improved capacity as well as increased safety for all road users.

**b. The Task**

- The task in this assignment is to carry out a [insert stage name] stage road safety audit of the proposed [insert name of project] so that potential road safety problems can be identified, discussed and minimized before the project is completed.
- The audit shall be undertaken in accordance with the process detailed in the current edition of the CAREC "Road Safety Audit" manual.

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**c. Scope of Services**

The scope of services required of the audit team will include the following:

1. That the audit be undertaken by an audit team of at least two auditors.
2. That the Team Leader is a registered Senior Road Safety Auditor in the national register of road safety auditors.
3. Attendance by the Team Leader at a Commencement Meeting with the Project Manager and designers in order to obtain full information about the proposal and an understanding of the background to the project.
4. A review of the all documents provided by the Project Manager prior to inspecting the site and again prior to finalising the audit report.
5. Day and night time inspections of the entire site so as to get a better understanding of the existing traffic situation and an insight into how the finished project will look.
6. The auditors should consult the appropriate checklist in the CAREC "Road Safety Audit" manual, but not limit their concerns to those listed. They should look at the safety needs of all future road users of this location, especially vulnerable road users.
7. Preparation of a concise road safety audit report in the format outlined in the current edition of the CAREC "Road Safety Audit" manual.

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## 5 What to do with an audit report.

- The audit team leader is responsible for the audit report.
- It gets sent to the Client (usually the Project Manager)
- The Project manager is required to respond in writing to all the recommendations. Not always agree, but certainly respond in writing.
- If there is uncertainty, meet and discuss. Get more inputs to make a considered decision.
- The Project Manager is then responsible for getting all changes to the design made and followed up.

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**But why do some audits not achieve a safer road?**

- How can ADB work with the local Ministry to ensure that safety concerns are genuinely and openly discussed and resolved?
- The RSA report gets sent to the Client (via the Project Manager)
- Some Project Managers do NOT respond. Why?
- Some dismiss the RSA report as "non-standard".
- Some say the audit team was "poor" or "do not know the real conditions in our country"
- In reality – some of the Project Managers either:
  - Do not understand the RSA process, or
  - Take the comments personally (which they should not)
  - Or are too worried about time/budget.

- HOW CAN WE CHANGE THIS?
- AUDITS ARE WORTH FIGHTING FOR!

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My first and most important recommendation

**BUILD UP THE ROAD SAFETY ENGINEERING PROFESSION IN YOUR COUNTRY**

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# Managing and learning from audits – some lessons from the six stages of road safety audit

The earlier we audit a proposal the safer, cheaper, better for all.

Phillip Jordan, Consultant to the ADB "Enhancing Road Safety for CAREC Member Countries Program"

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Objectives:

- To show typical road safety features commonly found in the 6 stages of audit
- To encourage you to undertake audits as early as possible
- To ask what you make of "standards" vs "safety"

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Feasibility stage
Preliminary design stage
Detailed design stage
Road works stage
Pre-opening stage
Existing road (inspections)

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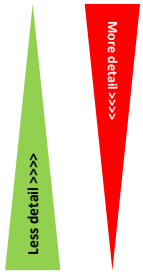
## The 6 stages of audit:

Feasibility stage
Preliminary design stage
Detailed design stage
Road works stage
Pre-opening stage
Existing road (inspections)

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DUSHANBE – KURGONTEPPA HIGHWAY(CAREC 2,5 6) DUPLICATION – PHASE TWO

Feasibility stage

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## Safety concerns (big issues!)

- Duplicating on the existing alignment, leading to high speeds through 4 towns
- Four key intersections
- Roadside hazards
- Cattle

**Look for "big" safety issues, and question safety in the planning**

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## Project location map showing approximate alignment only

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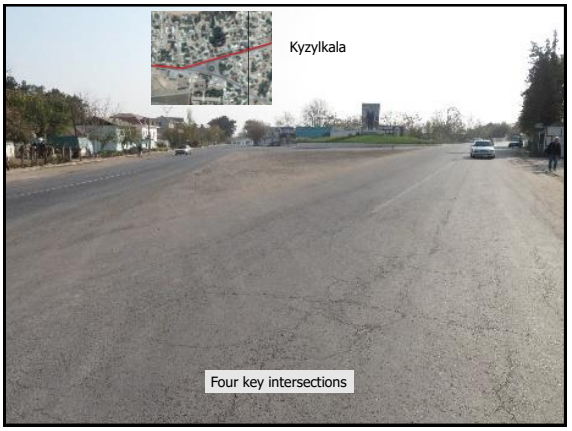


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**Recommendations:**

- Develop by-passes for four towns.
- If not possible, traffic calm (gateways, road humps).
- Intersection designs to maximise safety and assist pedestrians to cross.
- Adopt a clear zone of 10m (rural) and 4m (urban)
- Place second carriageway on alignment that keeps roadside hazards outside agreed clear zone
- Cattle underpasses (and marked crossing points)

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DUSHANBE – KURGONTEPPA HIGHWAY DUPLICATION – PHASE ONE

Preliminary design stage

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## Safety concerns (also "big" issues)

- High speeds through village of Ovi Shivu
- Bus/taxi stops in rural areas – how will we provide safely for pedestrians?
- Roadside hazards – clear zones not used
- U turn designs

**Look for "big" safety issues, and question generic design issues**

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## 1 High speeds through Ovi Shivu

- Vehicle speeds will increase
- The central median will assist pedestrians to stage their crossings
- But high speeds will allow no tolerance for errors
- Impacts above 40km/h are often fatal for the pedestrian

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## Options to reduce speeds (for pedestrian safety) in Ovi Shivu

- Do nothing, only use speed restriction signs
- Police enforcement
- Electronic enforcement via overhead cameras, radars
- Traffic calming – gateway signs, 40km/h speed limit, flat topped road humps

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## Audit recommendations to reduce speeds through Ovi Shifu

- Gateway signs and 40km/h speed limit
- 1.6m wide paved median (with no barrier) – to serve as a pedestrian refuge through the village
- Flat topped road humps at 100m centres approx.
- A pedestrian bridge may be installed near the southern end of the village to serve (mainly) school children. The audit team has no objections to this but believes it will be unlikely to assist many pedestrians despite its high cost.

**ALL WERE AGREED**

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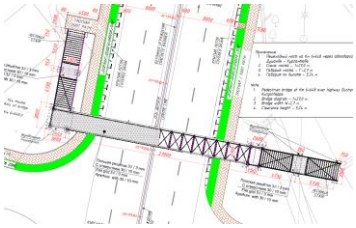
**Recommendation for speeding through Ovi Shifu**



There is no objection to the proposed pedestrian overpass in Ovi Shivu (but it is unlikely to offer much service to the pedestrians of the village). It will not assist the disabled, or those with loads. It may assist school children if they are required to use it by teachers/parents. It will have 32 steps up and 32 steps down.

It is not to be a substitute for traffic calming through the village.

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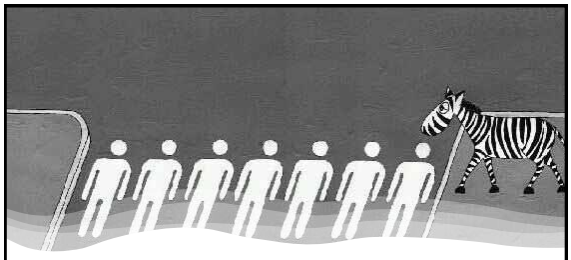

2 Bus/taxi stops in rural areas.

Zebra crossings were proposed

Zebra crossings offer no safety for pedestrians currently, and in this country.

Plus - they should never be used in high speed locations, anywhere.

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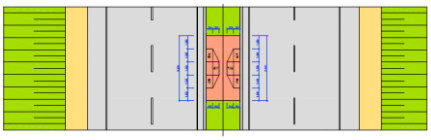
**Recommendation for bus/taxi stops in rural areas**



At locations near bus stops in rural areas, the median should be paved (as shown); warning signs should be used to alert drivers to the bus stop and also the possibility of pedestrians.

There shall be NO ZEBRA CROSSINGS in rural areas.

The trees/vegetation on the median will be kept clear to help pedestrians to see and be seen.

**ALL AGREED**

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3 Roadside hazard management - clear zone concept was not used in the design

- Vehicle speeds will increase
- Driver fatigue due to "easier" driving will result.
- More run-off-road crashes will result.
- Roadside hazard management is vital.
- What clear zone(s) have been used?

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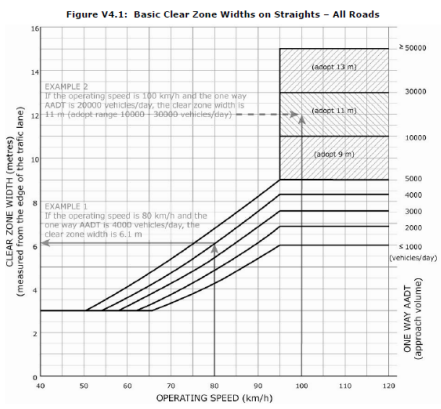


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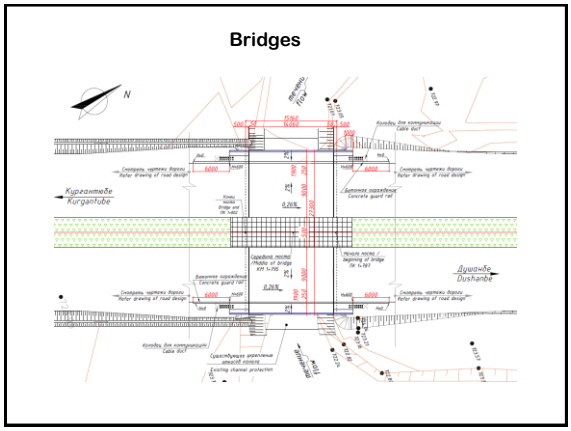


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## Delineation (tactile edge lines and plastic guide posts)

- Because of higher speeds and higher risk of driver fatigue, excellent delineation is essential.
- Tactile edge lines should be used on each carriageway
- Plastic guide posts should be used.

AGREED

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**5 Concerns for U turn designs**

- U turns on other highways suffer from no sheltered turn lane, plus they are too wide. Most lack good signage.
- All U turns on this Hwy should have a sheltered deceleration lane.
- The opening should permit one vehicle only per direction to turn at a time.
- Sheltered lanes should be provided at intersections to also facilitate U turns.

AGREED

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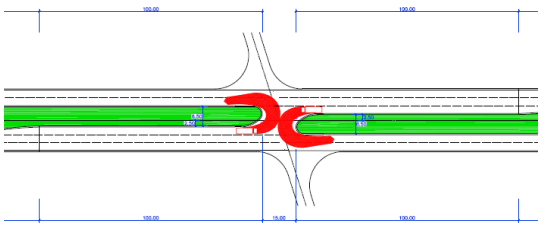
U turn designs



AGREED

U-turns are to be redesigned to provide sheltered turn lanes, and a narrower width across the opening to reduce double or triple stacking by drivers

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**Preliminary design stage audit recommendations:**

- Traffic calming (gateways, road humps) in Ovi Shivu. AGREED
- Adopt a clear zone of 10m (rural) and 4m (urban) AGREED
- No Zebra Crossings in rural areas AGREED
- Wider paved shoulders AGREED (WHERE POSSIBLE)
- Safer bridge cross section and barrier. **NOT AGREED**
- Stronger delineation and tactile edge lines AGREED
- Sheltered left turn lanes at U-turns. AGREED

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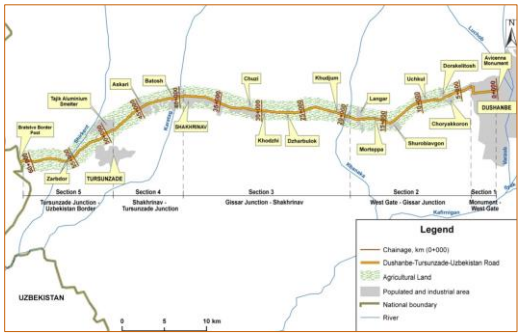


85

The detailed design audit was undertaken after construction started. Too late. It identified many safety concerns:

Rural sections

- Pedestrians crossing highway to get to bus stops (barrier will be in their path)
- Zebra crossings at bus/taxi stops in 100kmh zones
- U turns will lack sheltered lanes
- Unpaved shoulders

Urban sections

- High speeds through villages
- Pedestrians crossing highway in villages
- Roadside hazards (light columns, drains)

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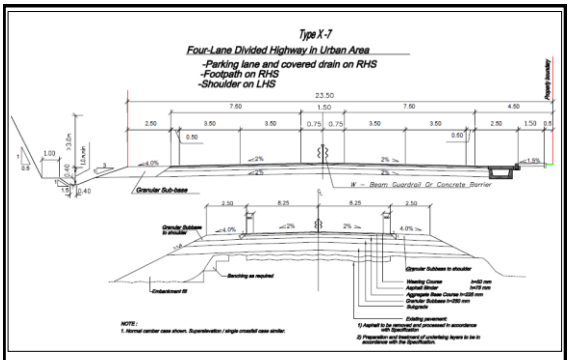
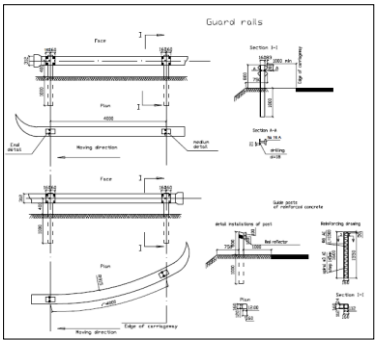



Look for details in the drawings - geometry, intersection details, signs, delineation, roadside hazards, pedestrians

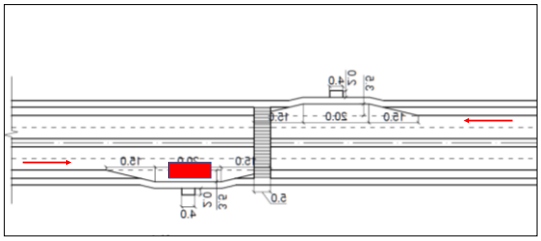
87




Look for details in the drawings - geometry, intersection details, signs, delineation, roadside hazards, pedestrians

88

100kmh speeds – never install a Zebra

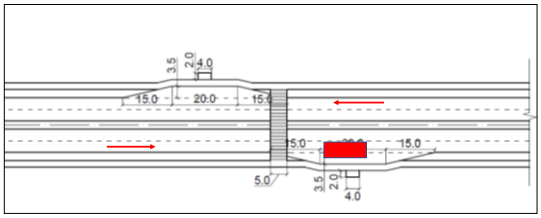


Driving on right side. If this design is built, the bus may obscure sight lines to/from a pedestrian on the crossing. Safer to place the bus stop beyond the crossing, or no crossing at all

89

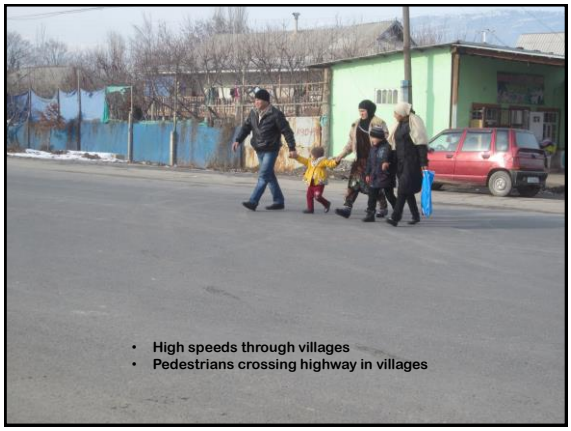
Safer!

100kmh speeds – never install a Zebra even if this design is used!



Driving on right side. With this configuration, the bus will not obscure sight lines to/from a pedestrian on the crossing.

90

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What road safety improvements did the audit achieve?

Sadly – none. (It was too late!)

No one can say what happened to the audit report.

No responses to the recommendations have been seen from the Project Manager.

Some major changes were made to intersections after the construction began – not in the design - increasing risk!

94


95

Road work sites on the A380, western Uzbekistan

- No compliance with the 6 zone concept.
- Inconsistent road work speed limits.
- No warning of end of road.
- Rough and unsafe cross track.
- Essential "Two Way Traffic" signs not used.
- Most workers not wearing reflective safety vests.
- Flagmen…..

Look for wrong signs, missing signs, poorly placed signs, delineation, question work methods and worker safety

96

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Recommendations for these road work sites on A380

- Follow the 6 zone concept in the CAREC manual.
- Adopt a consistent road work speed limit.
- Ensure all carriageway changes are signed 500m and 250m in advance; correct information and warning signs.
- Pave each "crossover track".
- Use "Two Way Traffic" signs in single lane operations
- All workers to wear reflective safety vests.
- Trained traffic controllers employed (not flagmen) and to use Stop/Slow batons

103

PRE-OPENING STAGE

Socialist Republic of Vietnam
Ministry of Transport
Vietnam Expressway Corporation

**Road safety audit findings and recommendations for safety improvements for the Da Nang – Quang Ngai Expressway**

DANANG-QUANG NGAI EXPRESSWAY
DEVELOPMENT PROJECT NO. P106235

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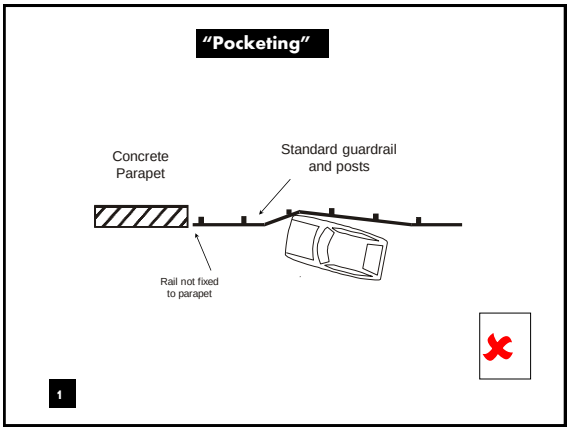


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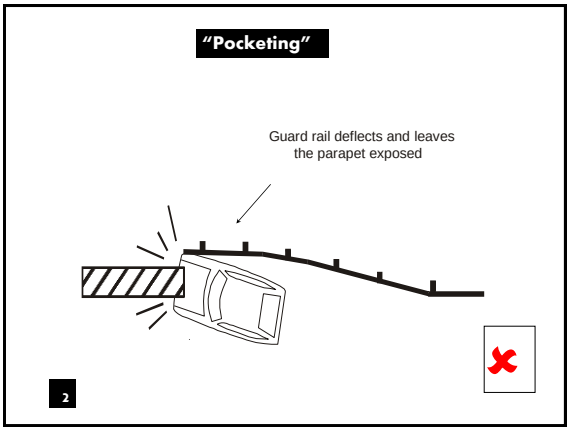


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139

**The Ayni-Panjakent Highway opened in 2016**

- Rigid light columns
- Not enough safety barrier (but unsafe terminals)
- Concrete barricades – unsafe
- Not enough delineation
- Unpaved bus laybys
- Open drains in clear zone
- Unsafe intersections
- Traffic signals with inadequate pedestrian clearance times
- Zebra crossings in high speed areas.....and more

**Road is constructed;
All changes will cost $$.
Look for all/any safety issues - big, medium, small.**

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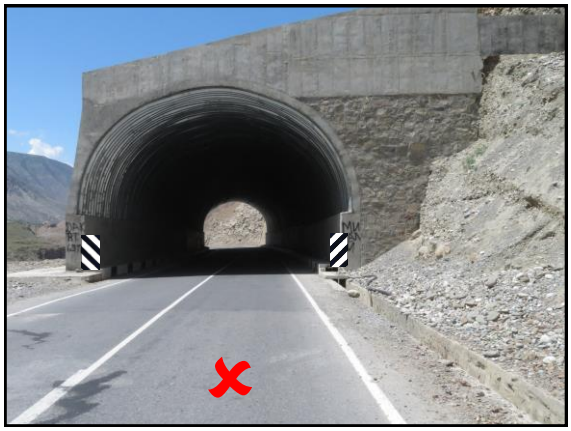

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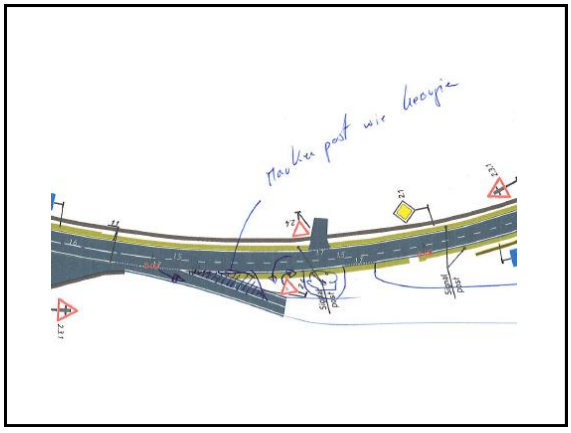


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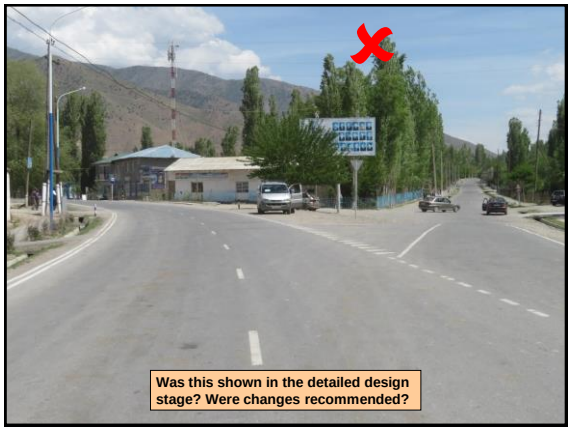



155

Recommendations for the Ayni – Panjakent Road (CAREC 6)

- Consistent delineation – guide posts, chevron alignment markers.
- Increased lengths of safety barrier.
- Six improved intersection layouts.
- Remove all Zebra Crossings from high speed locations.
- Pave shoulders to the barrier or the drain
- Pave bus laybys consistently
- ADB is seeking funding to make these safety enhancements

159

ADB

Road Safety INTERNATIONAL

ASIA PACIFIC ROAD SAFETY OBSERVATORY

"Practical Road Safety Engineering" online workshop

Module 7 – principles of safe intersection design

160

Principles of safe intersection design

Phillip Jordan Road Safety

161

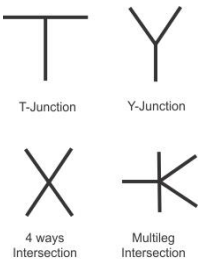
Objectives of this presentation

- To explain why safety at intersections is important.
- To give some details of what to look for – and how to improve safety at - your intersections (new and existing).

162

An intersection is defined as :
"a place where two or more roads meet at grade".

Intersections are high risk locations because different road users (trucks, buses, cars, pedestrians, motorcycles) are required to use the same space.

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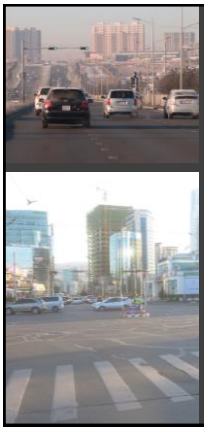




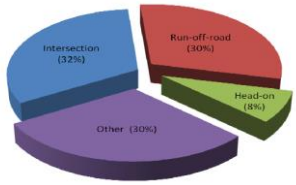
Intersections are critical locations in the road network in terms of capacity, level of service and safety.

They are the place where opposing streams of traffic have to compete for space and time.

They are high risk locations for crashes because road users on conflicting paths in intersections are required to use the same space; a collision is only avoided if they are separated in time!

164

**SERIOUS CASUALTY CRASHES – AUSTRALIA**




YOUR COUNTRY?

165

Intersections also present a risk of serious injury or death when a crash occurs because of the potential for high relative impact speeds.

Intersections are the location of up to 50% of reported *urban* crashes in most countries.

They are the location of between 10-20% of reported *rural* crashes in most countries.

166

## Intersections – the basics

- Safe geometry is an essential starting point.
- Traffic control is then critical.

167

The main forms of control at intersections are:

- Road Rules (no physical control and relying on a priority rule to indicate right of way).
- Priority road designated by 'Give Way' (Yield) or 'Stop' signs.
- Roundabout.
- Traffic signals (Fixed time or vehicle activated).

168

Road Rules (no physical control)
- relying on a priority rule


'Give Way' or 'Stop' signs

Traffic signals

Roundabout (rotary)

169

## The basic principles of safe intersections:

- Priority to major traffic.
- Clear "right-of-way".
- Separate conflicts (in space and time).
- Minimise conflict areas.
- Minimise difference in relative speeds between vehicles
- Defined vehicle paths
- Provisions for all vehicular and non-vehicular traffic.
- A design which is "simple" and consistent.

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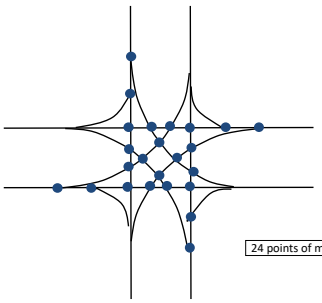
## In line with these objectives we will discuss:

| | | | | |
|---|---|---|---|---|
| Minimum number of conflict points | Relative impact speeds | Visibility to/from the intersection | Intersection control - roundabouts and traffic signals | The need for sheltered left turn lanes |

171

## 1 Conflict points at intersections

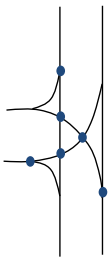


The fewer conflict points – the safer!

24 points of major conflict

172

## 1 Conflict points at intersections

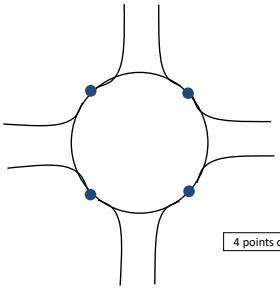


The fewer conflict points – the safer!

6 points of major conflict

173

## 1 Conflict points at intersections



The fewer conflict points – the safer!

4 points of major conflict

174

## 2 Relative impact speeds

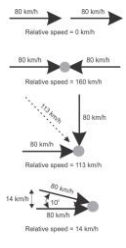



Figure 2.8 Relative Speed

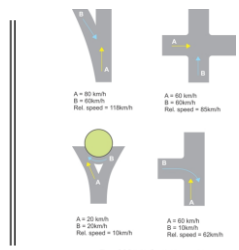


Figure 2.9 Relative Speed at Intersections

175


176

Y junctions are very dangerous!

177

Try to eliminate each Y-junction by…

- Converting to a T-junction
- Converting to a roundabout
- Signalizing (urban areas)
- Closing one approach

T-junctions are safer because they:

- Control the turn speed
- Reinforce priority
- Enhance sight lines

178

Conversion of Y junction to a T junction in a rural area

Because the side road intersects the main road on the outside of a curve, make sure drivers on the side road can see the intersection in sufficient time (ASD)

179

## 3 Visibility to/from the intersection

Each driver/rider needs to recognise the intersection in sufficient time to be able to react safely.

Every approaching driver/rider needs to be able to recognise and understand the priority that applies at the intersection.

Providing Approach Sight Distance (ASD) is the best way to ensure this.

180

ASD is the minimum level of sight distance which should be provided at an intersection.

It is defined as "the distance travelled by a vehicle between the time when the driver receives a stimulus indicating a need to stop, and the time that the vehicle does come to a stop".

This distance is sufficient for drivers/riders to be able to see the line marking at the intersection.

181

## Basic elements of intersection safety

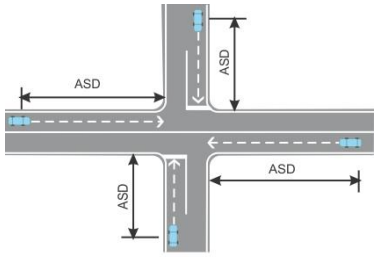



**Figure 2.2** Approach Sight Distance

For driving on left side of road

182

- ASD – approach sight distance
- SISD – safe intersection sight distance
- ASD addresses overshoot crashes
- SISD addresses restart problems

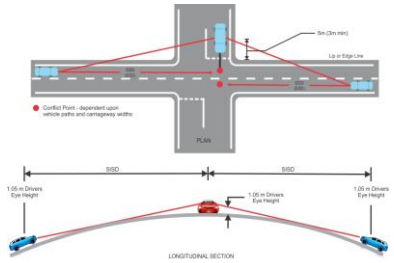



Figure 2.3 Safe Intersection Sight Distance

For driving on left side of road

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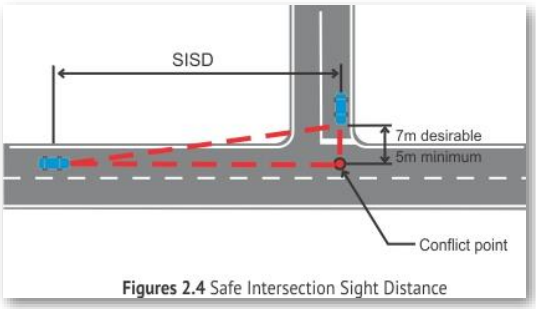



**Figures 2.4** Safe Intersection Sight Distance

For driving on left side of road

184

**Table 2.2** Safe Intersection Sight Distance

| SPEED ON MAIN ROAD (km/h) | SAFE INTERSECTION SIGHT DISTANCE (m) |
|---|---|
| 40 | 66 |
| 50 | 89 |
| 60 | 113 |
| 70 | 140 |
| 80 | 170 |
| 90 | 203 |
| 100 | 240 |

185

4 Intersection control

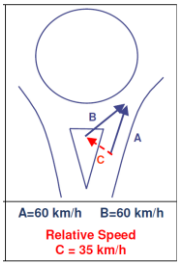
Roundabouts are the safest form of intersection control.

Why?

186

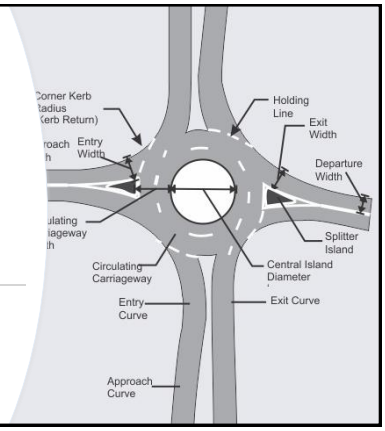
Why are roundabouts "safe"?

- Few conflict points (only four)
- Good geometry induces slow entry speeds
- Clearly defined "right of way"
- Simple decision making process for drivers/riders
- Low relative impact speed (if collisions do occur)




187

For driving on left side of road

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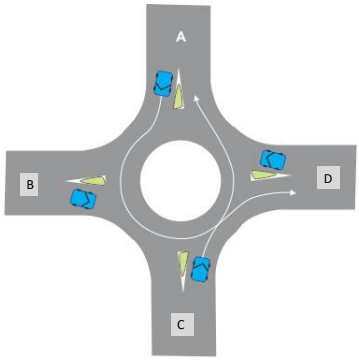


Roundabouts function best with "balanced flows"

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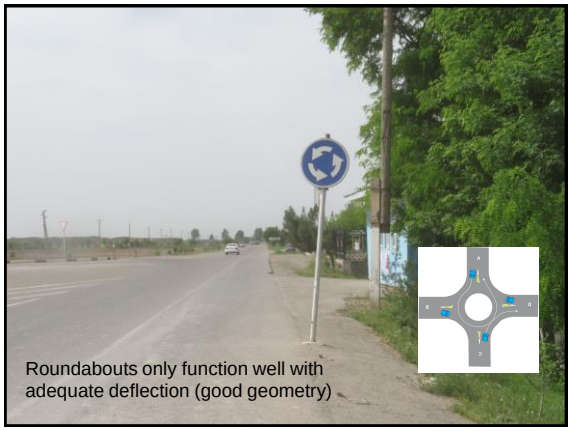
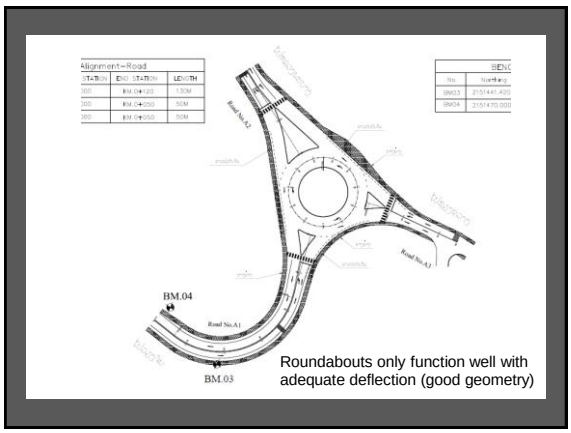


Roundabouts only function well with adequate deflection (good geometry)

190

What do you say about this roundabout on a CAREC Highway?

191




Roundabouts only function well with adequate deflection (good geometry)

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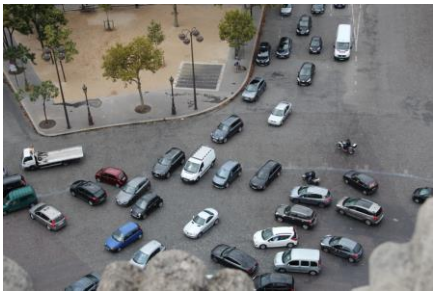
## Roundabout - Paris



Arc de Triomphe, Place Charles de Gaulle, Paris

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197

## Swindon, UK

198

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Intersection safety

*Appropriate sites* for roundabouts include:

- where stop/give way sign control causes unacceptable delays
- where traffic signals would result in greater delays
- where there is a high proportion of left (right) turning traffic
- intersections with more than 4 legs

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Intersection safety

*Appropriate sites* for roundabouts include:

- cross intersections where there is a history of crossing or turning crashes
- rural intersections where speeds are high
- local street intersections
- at intersections where the major movement is a turning movement (eg. in small towns where a highway takes a left (right) turn)

200

Intersection safety

*Appropriate sites* for roundabouts include:

- Y or T intersections (these tend to have a lot of left (right) turn vehicles)
- where traffic growth is expected to be high but patterns are uncertain
- local roads and collector roads where priority for one route is not desirable (for traffic calming reasons)

201

Intersection safety

*Inappropriate sites* for roundabouts include:

- where a satisfactory geometric design cannot be achieved
- where traffic flows are "unbalanced"
- major/minor road intersections
- sites with considerable pedestrian activity #
- at an isolated site within a linked traffic signal network #

# - this is variable and should not automatically discount a site

202

Intersection safety

*Inappropriate* sites for roundabouts include:

- where peak hour reversible lanes are needed
- where *very* large vehicles are common
- where nearby traffic controls may cause queuing back into the roundabout

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Roundabouts are good for safety

Safety performance of roundabouts

- Safe because of reduced numbers of conflict points.
- Safe because of the general reduction in traffic speeds.
- Safe because high angles of conflict are eliminated.
- Safe because of the relative simplicity of decision making at the entry.

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Roundabouts are good for safety

- Safe because long splitter islands at high speed locations give good warning of the presence of an intersection.
- Safe because splitter islands give a refuge for pedestrians.
- Safe because roundabouts require a "conscious action" by motorists as they pass through, regardless of the presence of other vehicles.

Most significantly, roundabouts REDUCE the types of crashes where people are seriously hurt or killed by 78-82% when compared to conventional stop-controlled and signalized intersections, per the AASHTO Highway Safety Manual.

205

Roundabouts are good for safety

But your roundabouts will only work well when…

- They are designed with suitable geometric deflection for all approaches.
- Drivers slow down and give way before entering.
- Traffic Police enforce the Road Rules for roundabouts.
- In the early days, public awareness campaigns may be needed to make users aware of how to correctly use the roundabouts.

Most significantly, roundabouts REDUCE the types of crashes where people are seriously hurt or killed by 78-82% when compared to conventional stop-controlled and signalized intersections, per the AASHTO Highway Safety Manual.

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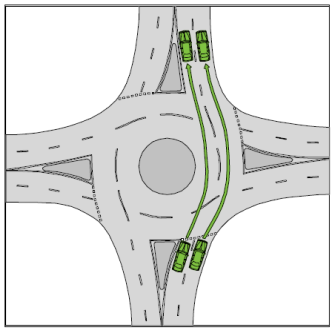
207

Exit line marking for multi-lane roundabouts



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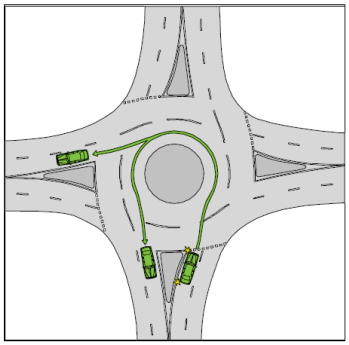
Exit line marking for multi-lane roundabouts



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211

## Traffic signals reduce crashes by 45%

(Victoria CRF)

**Vehicle activated signals are safer, more efficient. They need vehicle detectors**

- Detectors on each approach tell the controller when a vehicle approaches.
- The controller decides which approach has most vehicles waiting and turn it to green.
- Signal phasing permits full control of agreed turns (usually left turns).

**Fixed time signals are cheaper, but can encourage "red-light running**

- Fixed time signals may have several plans that operate across the day/week.
- But they cannot recognise occasions when traffic builds up on one approach.
- Frustrations can increase when lots of vehicles are help up, and few are moving.

212

213

For maximum efficiency traffic signals should be vehicle activated.

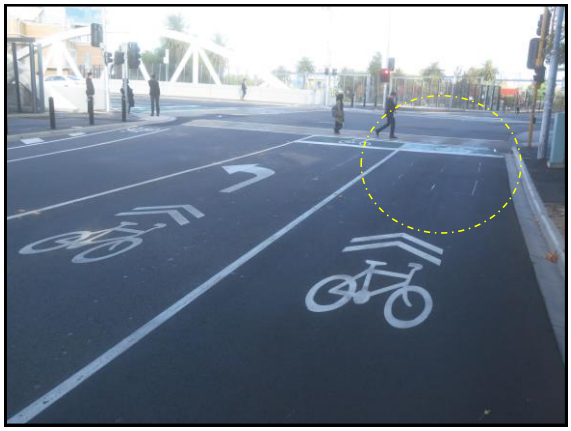
These have detectors on each approach.

The detectors tell the controller which approach has vehicles on it, and gives more time to that approach.

More efficient than fixed time signals – and also safer!

Why? Because drivers/riders know they will get short delays, they begin to trust the signals, and most then obey the red signal.

214



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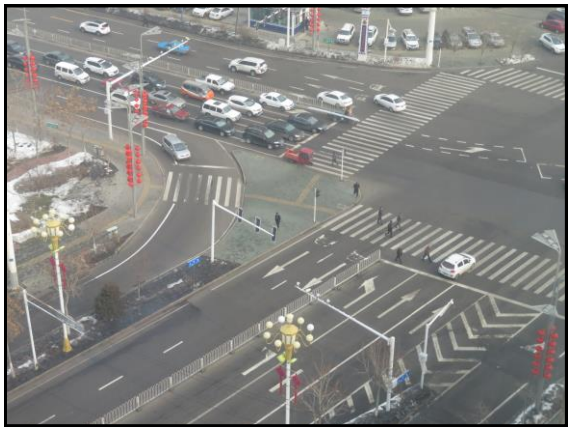
## Traffic signal hardware, civil works, and signal timings

Hardware:
- Conspicuous
- Clear
- Pedestrian and vehicle detectors
- Clear line marking
- Dropped kerbs for pedestrians
- Large islands

Timing
- No conflicts between opposing flows
- Sufficient time for the volumes
- Clearance time between phases
- Clearance time for pedestrians
- Fully controlled turns

216



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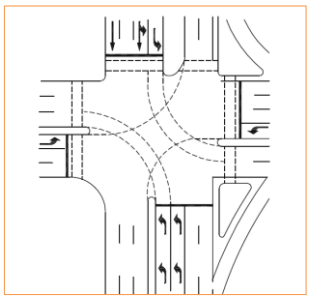

Turn lines assist left turners to more safely negotiate large intersections

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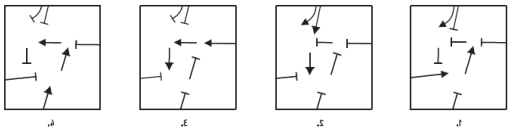

Check the traffic signal phasing

Arrow – traffic can move
Stem – traffic cannot go

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5 Provide sheltered left (right) turn lanes, especially on high speed roads

- Reduce the risk of rear-end collisions
- Give a safe storage area
- Needs a median 5m+ wide
- Needs sufficient length for easy deceleration plus storage

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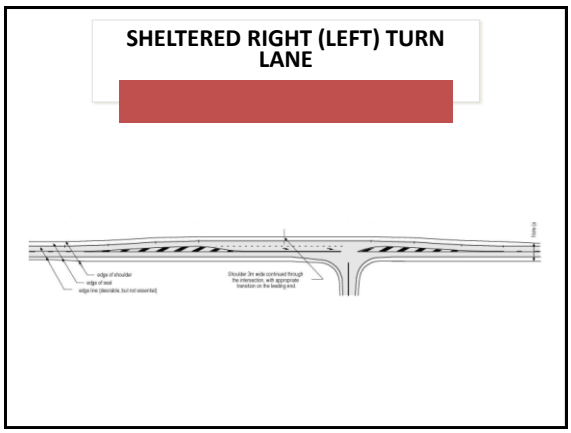


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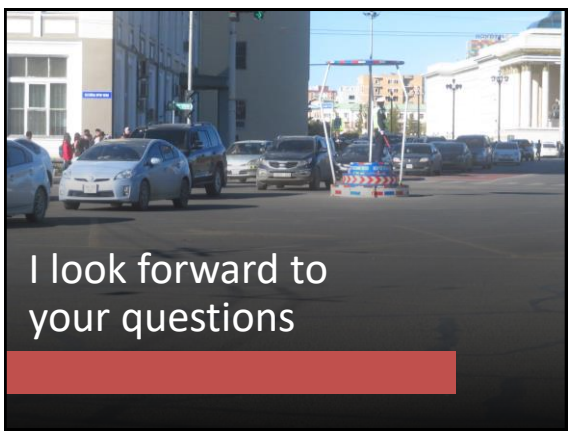


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