Road Safety Guidelines

for the Asian and Pacific Region

4.4

SAFE PLANNING AND DESIGN OF ROADS

Asian Development Bank

4.4

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Road networks in most developing countries are still being expanded and/or rehabilitated, and opportunities therefore exist to incorporate safety practices (at marginal cost) during the planning and design stages.

Many components of the design process can influence the level of road safety and some of the more important of these are discussed in this section. Simply adopting international design standards from developed countries will not necessarily result in levels of safety that are achieved in such countries because these standards are generally accompanied by effective enforcement, driver training, and publicity. These may not be operating as efficiently in developing countries and, in any case, the traffic conditions and types of traffic using the roads will be different.

More emphasis, therefore, needs to be placed on examining how to make the road network operate safely in the particular operating environment and traffic conditions that exist in each country.

- In **rural road rehabilitation** schemes, opportunities should be taken to minimize direct major road access, keep traffic speed relatively low when such roads pass through small communities, and eliminate Y-junctions.
- **New roads** may require the inclusion of additional safety features such as cycle lanes.
- **Urban areas** may require design of road networks to establish a road hierarchy, and the reduction of through traffic and speeds where pedestrian and cyclist activity exists.
- **On all roads**, greater emphasis needs to be given to the safety of the large proportion of vulnerable road users that normally exist in developing countries.

The Asian Development Bank (ADB), World Bank, and other development aid agencies have found that many potential safety problems can be avoided by safety checking of schemes during the planning and design stage (the safety audit process).

PRIORITY ACTIONS NEEDED

1. Require all proposed new and rehabilitation road schemes to be checked from a safety perspective during the design stage.
2. Review existing design standards, access control, and development control to ensure safety is given high priority, particularly for vulnerable road users in urban and rural areas.
3. Check that towns and cities have localized zoning, and that the existing road network is classified into a road hierarchy.

Developing countries need to adopt more safety-conscious design procedures when planning land use or improving their road networks. Safety audit (or safety checking procedures) should also be adopted to ensure that road networks are designed to be safer, particularly for pedestrians, nonmotorized vehicles, and motorcyclists.

1 INTRODUCTION

These sector guidelines on the "Safe Planning and Design of Roads" are from a set of Road Safety Guidelines for the Asian and Pacific Region policymakers, developed as part of a regional technical assistance project (RETA 5620: Regional Initiatives in Road Safety) funded by the ADB.

Road safety should be considered in a comprehensive way through all aspects of highway and traffic engineering works, including planning, design, construction, maintenance, and hazardous location treatments. Sector guidelines 4.4 and 4.5 concentrate on these important aspects. This section seeks to improve safety by preventing accidents through sound planning and good design, and 4.5 by accident reduction on the existing road network.

This section includes guidance on various elements of land use and highway network planning, the design of highways, and, in particular, the need for facilities for pedestrians, cyclists, and motorcyclists who often form a large proportion of the traffic in Asian and Pacific countries.

2 WHY IS SAFE PLANNING AND DESIGN NEEDED?

2.1 Planning

Planning is important because on all kinds of road, conflicts can arise between different types of road users and these may lead to accidents involving death or injury. These conflicts are typically most numerous in town centers, but can also occur on suburban or rural roads. Conflicts between the following types of road users are common in all countries:

Different modes

- motor vehicles versus pedestrians;
- motor vehicles versus nonmotorized vehicles, particularly cycles;
- heavy goods vehicles versus other road users;

Different movements

- high-speed traffic versus low-speed vehicles;
- all vehicle types at road junctions; and
- vehicles overtaking.

Roads in developing countries tend to be used by more nonmotorized vehicles and pedestrians than is the case in the more industrialized countries, where many design standards originated. There may thus be a need to amend standards or devise new ones that take into account the general usage of the national road network. Safety features (for example, pedestrian crossing facilities, motorcycle lanes, signs, and markings) should be considered at the earliest possible stage of road development. Financing for these safety features as well as for maintenance should also be planned at this early stage.

While many problems exist due to previous decisions and poor (or lack of) planning,

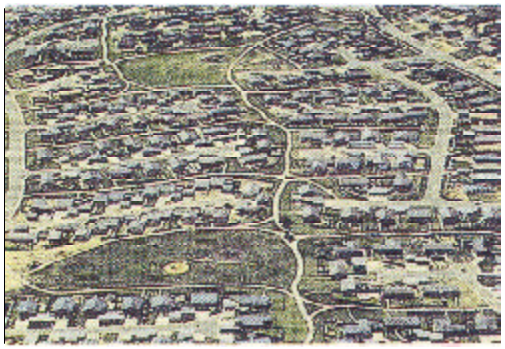
Plate 1:
Bicycle versus truck in Hanoi, Viet Nam.

it is never too late to rectify the situation or to plan for the future. This is particularly true for those developing countries where the infrastructure and traffic volumes are growing at a rapid rate (see Reference 1).

2.2 Safe Design

The second element being considered in this section is ***safe design***. This is relevant to all existing roads as well as all new projects. It tends to start with a country, recognizing the fact that it needs to have design standards for traffic signs and road markings, and also specifications for the geometric design of highways and intersections to accommodate the types of vehicles likely to be using the roads. A country should then develop specific safety design techniques and checking procedures such as a safety audit to ensure that standards are applied appropriately or departures from standards are carefully considered.

Plate 2: Well-planned roads in Australia.



Accidents are caused or influenced by a number of factors and the one that is most prevalent is human behavior.

Engineering design is, however, also important as it should accommodate a wide range of human behavior and encourage safer use of the roads. Sadly, this is not always the case and inappropriate engineering can be a factor in a high percentage of accidents. Indeed, engineering features are often easier and cheaper to change than human behavior, and can have immediate effect.

Engineering design can influence how a road is used at a particular location or under a particular set of circumstances. Young pedestrians, for example, will often tend to behave in a relatively irresponsible and unsafe manner. In some cases, this is due to their general inability to judge speeds accurately. They can, however, be helped to survive in the urban traffic environment by minimizing their need to come into conflict with moving vehicles by the use of segregated pedestrian crossings; for example, underpasses or footbridges.

Good planning employing safe design principles can thus help prevent conflicts arising in the first place. Safe design means ensuring the safety of all road users. Nonmotorized vehicles such as bicycles and rickshaws together with motorcycles and "tuk tuks" are particularly vulnerable. These road users often constitute large proportions of the traffic in the Asian and Pacific region on many roads, and due consideration should be given to them in the planning, design, operation, and maintenance processes. They should have priority on local and residential roads.

3 KEY COMPONENTS

3.1 Safe Planning

The main components in the planning process that influence safety are listed below, together with the key principles associated with each. More detailed guidance is given in Reference 1.

Road hierarchy: The roads in a network should be clearly defined and classified into those that are primarily to be used by traffic forthrough-movement and those that are used primarily for access to housing or other buildings and amenities, and where low speeds are required.

There should be clear, unambiguous priority indicated at each intersection so that traffic on the more important road is always given precedence over that from the less important road. Any road should only intersect with roads in the same class or one immediately above or below it in the hierarchy.

Catering for different transport modes: The provision of facilities for all different types of road users, including pedestrians, cyclists, other nonmotorized vehicles, and different forms of public transport gives the best opportunity for providing a safe traffic environment with minimum pollution and congestion.

Land use: Land uses should be distributed so as to minimize road traffic and pedestrian conflicts. The need for travel by vehicle should, where possible, be minimized by locating shops, work places, and schools within walking distance of homes, including, where feasible, separate networks of footpaths and cycle paths. Traffic and safety implications of all development proposals should be thoroughly examined before approval for construction is given.

The provision of an efficient public transport system serving the various land uses can

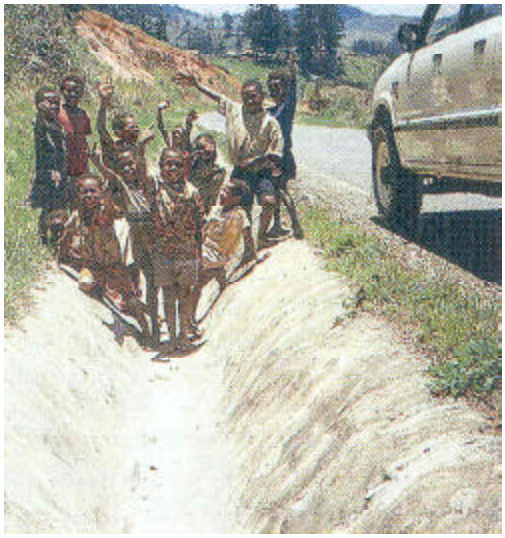


Plate 3: Potentially dangerous deep V-type ditches in Papua New Guinea.

greatly reduce conflicts in an urban area by reducing the overall numbers of vehicles on the road and, in particular, minimizing the problems of pedestrians. Careful planning of the road layout around bus or rail stations and bus stops is essential, and safe routes for pedestrians should be developed near these locations.

Access control: Direct frontage access onto major roads should be minimized. No access should be permitted at dangerous locations such as bends or hill crests. They should also be minimized at or near existing intersections. The construction of service roads for shops or industrial units should be encouraged.

3.2 Safe Design

In general terms, good safe design results in a driving task that is clear, simple, and consistent. Many countries in the region have developed their standards by adapting or modifying existing standards from developed countries such as the Association of American State Highway and Transportation Officials (AASHTO) [2], the National Association of Australian State Road Authorities (NAASRA)[3] or United Kingdom (UK) Departmental Standards[4]. Whatever national standards exist, the design of any location should always consider local traffic conditions and what is most appropriate for all road users at that location.

The road design should present necessary information in a systematic, sequential manner and should always minimize any elements of surprise. A full discussion on the merits of technical designs is beyond the scope of this document, but more guidance is given in Reference 1.

It is also important that care should be taken for the safe operation of roads under construction and maintenance, particularly in the developing world where construction tends to take longer and attention to the safety of workers, pedestrians and other road users is often inadequate.

Cross-section: The technical design of any road will depend upon its category within the road hierarchy (see above), and will comprise lane numbers and widths, shoulders, medians, and other features that are consistent with a set of national standards. It is particularly important, for example, that adequate width provision is made on road shoulders for pedestrians and animals.

Sight distances: A driver needs to see ahead in order to stop, overtake, cross, or merge with traffic in safety, and thus criteria are needed to ensure that the road design allows this to happen and that forward visibility is not obscured. At certain locations where forward visibility is a problem there may be a need to ban overtaking or to construct an overtaking lane. At road junctions, good visibility between major road traffic and vehicles emerging from the minor road is essential for safety. Visibility splays should be provided using the appropriate major road speed "stopping sight distance" as a basis for design.

Curves and superelevation: Horizontal and vertical curves should be designed so that they can be negotiated safely at speeds appropriate for the category of road. This is achieved by having criteria that match design elements, including radius of curvature, surface type, and superelevation with the speed of traffic. For example, radii should be similar for adjacent bends and large variations are to be avoided. Excessive vertical curvature at the top or bottom of hills can be dangerous and needs to be designed carefully in order to help motorists keep control and to ensure that they have adequate visibility. Sudden changes in alignment should be avoided; for example, when moving from flat to hilly terrain, the road should not change immediately from being straight to a series of sharp curves.

Speed limits : Speed limits should be clearly signposted and understood, and should always be appropriate to actual traffic conditions. Slower speeds mean fewer and less severe accidents, but they can rarely be achieved through the use of new signs. It may be necessary to use physical features such as road narrowing, road humps, and other methods to reduce speeds to the desired level, especially where such roads pass through small communities or villages, or where a lower speed is required (e.g., on approaches to single lane bridges). The use of road humps on principal roads needs to be carefully assessed because of noise and vi-

bration problems and the possibility of excessive traffic delays. Good advance warning should always be provided. Roads humps have been used successfully on principal roads in some countries where they pass through small communities or villages.

Road signs and markings: All countries should have standards for road signs and markings to inform and direct motorists, and especially to warn of hazards ahead. These standards should preferably conform to international conventions. Signs and markings should be applied consistently within a country and should be simple to understand with minimum wording. Signs should be carefully sited, well-maintained and should not be obscured by vegetation or other features. High-quality materials last longer, although the initial investment is high. Sign faces should be retro-reflective and road markings should be reflectorized thermoplastic where possible.

Drainage: Drainage ditches, channels, or culverts form an essential element of any road that is not on an embankment. They are needed not only for the short-term safety of road users during rain but also for the long-term structural integrity of the road. Poor drainage can lead to potholes and even the complete failure of the road. Deep drainage ditches too close to the side of the road can be a serious hazard to vehicles that run off the road. They need to be designed with care, particularly on bends. L-shaped ditches are preferred if they can be designed to cope with expected levels of water runoff.

In some rural areas the drainage channel is also the area used by pedestrians and thus needs to be designed with their safety in mind. Poorly maintained drainage, particularly missing or ill-fitting manhole covers, can be hazardous for pedestrians, cyclists, or motorcyclists.

Obstacles and safety fencing: The presence of roadside obstacles, street furniture, and trees have two implications: the first is the potential danger of collision; the second is the obstruction of visibility. Collisions can be prevented by installing safety fencing or high kerbs, or by removing or resiting the roadside feature. Visibility problems can be treated in a similar manner by removing or re-siting the object, or by ensuring adequate trimming of trees or vegetation.

Medians and barriers: Medians or central barriers can be used to segregate opposing streams of traffic thereby helping to prevent head-on collisions with their typically severe results. They can be used to restrict U-turns, to segregate different road users from each other (e.g., bicycle lanes), and to discourage pedestrians from crossing at unsafe locations.

Particular care is needed when designing medians and barriers to ensure that turning movements are catered for and emergency services are not unduly inconvenienced. Medians must be sufficiently wide to provide safe waiting areas where pedestrians are able to cross, and the ends of barriers should not themselves present a hazard (see Plate 5).

Lighting: The provision of adequate street lighting is a proven accident reduction measure in many countries. It is particularly helpful with regard to pedestrian safety or vulnerable vehicles operating without lights. Lighting is, however, expensive to install and maintain and poor maintenance can produce additional safety problems through uneven illumination. Lampposts should not be sited in positions where they will be a danger to a vehicle leaving the road. If this is not possible, then they should be designed to collapse on impact or be protected by safety fences. Where resources are limited,

Plate 4 (above): Movable concrete block and steel rail barrier in the People's Republic of China (PRC).

Plate 5: Vehicle impaled on incorrectly terminated barrier.

lighting should first be provided where the potential conflicts or danger are greatest, e.g., at intersections or at midblock locations of pedestrian crossings.

Bus stops and lay-bys: Bus stops and lay-bys allow vehicles to stop safely and with minimal adverse effects on other traffic. They should be positioned on straight, level sections of road and should be visible from a good distance in each direction. Bus stops should be located beyond pedestrian crossings and after intersections to avoid stopped vehicles from blocking other drivers' views of pedestrians crossing. Where goods are frequently sold at roadsides, the danger can be minimized by the provision of deep lay-bys to accommodate the stalls and parked vehicles.

Intersections: The basic principles of good intersection design are that they should allow transition from one route to another, or through movement on the main route, with minimum delay and maximum safety. The layout of an intersection should be simple and obvious to all road users and should cater for all types of traffic likely to use it. The type of intersection chosen will depend on traffic flows on the intersecting roads and what is appropriate, taking into consideration the standards of traffic control and management within the surrounding area. The advantages and disadvantages of different types of intersection are given in Table 1. Channelization and road markings should be used to position the driver at the correct and safest location for the driver to carry out the maneuver and to guide the driver through the intersection.

Pedestrian facilities: In urban areas in particular, walking is an important means of transport and arguably all road users are pedestrians at some stage of their journey. Pedestrian needs are, however, often neglected or given insufficient attention. Pedestrians are extremely vulnerable road users and tend to be involved in high numbers of accident deaths in many countries within the region. Young children form a large proportion of the pedestrian population, going to school or living near the road, and their road survival skills are often not as developed as those of adults. Pedestrian safety can be improved by a range of facilities, including the following:

1) speed reduction through traffic calming measures;
2) adequate footway areas kept clear of obstructions;
3) zebra or other types of crossings with or without pedestrian signals;
4) bridges or underpasses at busy locations;
5) barriers to prevent hazardous pedestrian movements;
6) pedestrianized streets;
7) central refuges to allow pedestrians to cross safely in two or more stages;
8) special crossing patrols for school pupils;
9) careful siting of bus stops to minimize

Table 1: Advantages and Disadvantages of Different Intersections

Intersection type	Advantages	Disadvantages
Grade separation - High flows	Minimal delays	Expensive
Traffic signals - Low to medium flows	Can accommodate heavy offside turns	Less space than roundabout High delays at off-peak times Electricity reliability needed Sophisticated maintenance needed
Roundabout - Low to medium flows	Good for turning and merging traffic Minimum delays at off-peak times	Poor safety record for cyclists Can become congested if traffic does not give way on entry to roundabout
Priority (give way or stop) - Low to medium flows	No delay to major road	Possible delays to minor road Adequate visibility needed

Plate 6: Pedestrianized street in the PRC.

Plate 7
Cyclists in the PRC.

Plate 8:
Little provision for pedestrians in India.

conflicts between moving vehicles and passengers embarking or disembarking; and

10) special care in the design of all roads where there are large numbers of pedestrians, particularly the young or elderly.

Bicycles and other nonmotorized vehicles: Bicycles and other nonmotorized vehicles are an important part of the traffic in most developing countries in the Asian and Pacific region, comprising more than 50 percent of the traffic on many city streets. They need separate consideration in a road system due to their slow speeds and vulnerability to injury when collisions occur. Problems related to safety and congestion typically occur at major intersections and they are best solved by providing grade-separated, segregated lanes for the bicycles and perhaps other slow-moving vehicles. A less expensive solution might be provided at-grade by bringing the segregated lane crossing points ahead of the main vehicle junction. Facilities for bicycles need to be attractive and well-maintained in order for them to be used. Facilities that are in use to a limited extent in some Asian and Pacific countries include:

1) slow lanes approximately 2 meters wide;
2) separate lanes segregated by a variety of barriers or fencing, ranging from a small narrow mound through various types of temporary fencing to a planted median or a concrete barrier;
3) separate phases at traffic signals;
4) bicycle only streets;
5) one-way streets for motor vehicles that permit two-way bicycle traffic;
6) streets that combine one-way motor vehicles in one direction with one-way bicycles in the other;
7) bridges or underpasses for joint use of pedestrians and bicycles with special ramps for cycle wheels;
8) shared use footways with pedestrians (preferably with marked lanes), often combined with a ban on bicyclists using the main road;
9) pedestrianized areas for bicycle access; and
10) parking bans for motor vehicles to ease the flow of the slow vehicles.

Providing facilities for bicycles and other nonmotorized vehicles not only improves safety but also reduces problems related to congestion and air pollution. Many of the worst cities in the world for congestion and pollution have failed to make adequate provision for nonmotorized traffic. More detailed guidance on facilities for vulnerable road users is provided in two other documents[5,6].

Traffic management: Safety and congestion within any city depend upon how well the traffic is managed. A comprehensive plan can produce many benefits using some or all of the following techniques:

1) parking restrictions and facilities;
2) control of minor intersections through signs and road markings;
3) the use of channelization at more important intersections;
4) one-way streets;
5) turning bays for traffic often combined with refuges for pedestrians;
6) central medians to restrict turning traffic;
7) pedestrian crossings, bridges, and subways;
8) segregated lanes for buses, bicycles, or other slow vehicles;
9) bus stops and other lay-bys;

10) traffic signals that respond to traffic demand;
11) linked traffic signals possibly using computer control; and
12) monitoring of traffic conditions through the use of local traffic police or possibly television cameras.

Safety audit: Many developed countries have discovered that even when highway and traffic schemes were professionally designed to the latest standards they could still lead to unnecessary accidents. A common finding was that accidents tended to occur at the ends of schemes where there was a transition to a road of a different standard, or related to pedestrians or other vulnerable road users whose particular needs had not been given sufficient attention. These design deficiencies can best be reduced or eliminated by an independent road safety specialist reviewing the designs at various stages in the design process. The specialist identifies any potential problems and makes recommendations for improvements. There then needs to be a system that rigidly reviews the recommendations and follows up with the required design changes.

This design checking system is called safety audit[7,8] and is mandatory for various types of schemes in Australia, New Zealand, and UK. It is also being used increasingly in the developing world, for example, in People's Republic of China (PRC), Fiji, Malaysia, and Nepal, and is commonly a requirement for aid-funded road projects.

Safety audit was initially developed for new roads but is increasingly being used to check and improve safety on existing roads. Safety audit reports are prepared at different stages of the design process, such as:

1) feasibility stage;
2) preliminary design;
3) final design;
4) before opening; and
5) after opening.

The latter stage may be considered to be part of an evaluation and monitoring process or, as mentioned above, can be carried out on an existing road. For the process to be successful there needs to be a firm policy commitment from the highway authority responsible for the road design and, in due course, this should be supported by legislation.

Following the establishment of safety audit policy, the difficulty encountered in most countries is the lack of skilled auditors with the relevant experience. Ideally these should be highway or traffic engineers with several years' experience in the analysis of accidents and the design of remedial measures. Only a few developing countries have sufficient numbers of these people and thus safety audit training will be an essential component for establishing the procedures within any country.

Foreign experts can be and are being used increasingly by the World Bank and other funding agencies for safety auditing major road projects around the world, but consideration should be given to developing local expertise. For example, the successful establishment of road safety audit nationally could include the following components:

1) designation of a road safety audit manager;
2) overseas visits to learn about procedures;
3) visiting experts to carry out pilot audits and training sessions;
4) development of national road safety audit guidelines and procedures;
5) development of policies and legislation related to national roads; and
6) continuing training of local engineers.

The lack of safety checking or auditing is of particular relevance in the developing world because such countries are still developing their basic road networks. Safety audit quickly improves the safety awareness of all design engineers and could have beneficial effects by eliminating potential future accident sites before they are built into the network where they are likely to remain unsafe for many years into the future. Opportunities exist during road rehabilitation projects, for example, to eliminate Y-junctions, to reduce accesses, and to reduce speeds as roads pass through communities. Failure to take such opportunities during the design stage will result in a less safe road than existed before the rehabilitation.

There are large differences between countries in the road environment and the road user mix on the roads. Use of international design standards does not necessarily mean the road will operate safely, as a developing country may have a completely different mix of nonmotorized vehicles, agricultural traffic, and pedes-

trians. In addition, there may be many problems associated with street vendors and encroachment. These differences can be foreseen via safety audits and appropriate changes recommended in order to ensure that the road will operate safely in the particular conditions that apply in that country.

It is difficult to predict the actual costs and benefits of safety audit, but in the developed countries the cost is typically equivalent to the cost assigned to one injury accident, and it is argued that this can easily be saved within the first year. In developing countries the benefits are potentially even greater.

3.3 Safe Operation

Maintenance needs: All the safety measures described in the preceding pages can fail if they are not properly maintained. This is particularly true of sophisticated equipment such as traffic signals using electronic controllers or computers. But it can also apply to more basic engineering techniques, such as drainage channels that can block up and become completely ineffective if ignored. Provision must be made for regular maintenance before any particular measure is adopted. Maintenance is particularly important for road markings (which can wear out in a matter of a few months) and for signs (that can be vandalized or obscured by vegetation growth).

Enforcement needs: Traffic police are readily visible in most developing countries, particularly at urban intersections. They can help improve the effectiveness of any safety measure by ensuring that the facilities are used correctly. It is important that the police understand any new facilities that are constructed and that their efforts to enforce regulations and penalize irresponsible road users are focused in a way that is most effective in reducing safety and capacity problems. This requires a close liaison between the engineers and police. Traffic police need to be trained to ensure they see their role as increasing safety rather than just maintaining the traffic flow. It is particularly important to have trained police carrying out enforcement activity when a new scheme or intersection is opened in order to guide and direct road users during the initial period. That is, until the public becomes familiar with the facility and how to use it.

Road user education: This should be a major consideration in planning and design because traffic can be expected to flow safely and smoothly only when all the road users understand clearly both the layout of the road and how they are supposed to behave. This is best achieved by simple design and good clear road marking, but a precise set of rules that sets out correct behavior in all common situations, and that is well-enforced, is essential. However, at times the rules need to be reinforced by publicity and education. This is particularly true when new regulations or measures, such as segregated facilities, one-way movements, or new types of intersection, are introduced. Many developing countries use the media to publicize important messages related to traffic. Targeting of young people through their schools is increasingly being used to spread important road safety messages, particularly related to pedestrian behavior. Indeed, road safety should be a part of the national primary school curriculum (see Sector Guidelines 4.6).

4 STAGES OF DEVELOPMENT

The key stages in developing a safer planning and design process normally include:

1) regulations in place covering land use, development, vehicles and road users, road signs and markings, highway design standards, and safety audit;
2) a traffic act requirement introduced stating that the road authority must make efforts to improve safety on its networks and to report annually on the action taken (and subsequently its effectiveness);
3) road authorities set up a small safety team to monitor the network and identify problems;.
4) staff and financial sources found to implement a traffic act;
5) regulations applied and procedures developed covering development control, access control, uniform design standards, and safety audit;
6) training requirements are met to increase skill levels of local engineers;
7) monitoring and improvement of safety problems on existing road network;
8) systematic safety audits of all proposed schemes are carried out; and
9) as experience is gained, new advice

Plate 9:
Cycle lane in the United Kingdom (UK).

notes and guidance manuals by safety specialists are issued to road authority engineers with particular emphasis on improving safety for vulnerable road users such as pedestrians, cyclists, and nonmotorized vehicles.

Technical assistance in all these stages can be provided by development banks and funding agencies.

5 BENEFITS AND EFFECTS

Plate 10:
Lane for bicycles in Hanoi, Viet Nam.

The application of the techniques listed above should lead to an environment that is safer for all road users. A good planning and design process will help minimize conflicts by:

1) reducing the number of local trips and trip lengths by better land use and public transport;
2) helping to ensure local trips are separated from the higher speed through-traffic;
3) optimizing modal separation and local needs; e.g., pedestrian requirements are served by providing better facilities than those found in the industrialized countries;
4) providing guidance and warnings to road users of changes in the road environment; and
5) ensuring safety hazards are not included unintentionally in new schemes, for example, deep V-ditches on rural roads, dualling, keeping existing uncontrolled access, and visual traps such as troughs or unbroken sightlines across junctions with major roads.

While many of the techniques require funding, they can all be considered to be an investment. To ignore the techniques can lead only to unacceptable conditions that will have damaging financial implications for the cities and countries.

6 EXAMPLES OF GOOD PRACTICE

Japan, UK, United States (US), and countries in Australasia and Europe have arguably the most advanced and sophisticated road planning and design techniques. They are also in many cases rediscovering the bicycle and designing special facilities aimed at reducing problems of safety, congestion, and air pollution. Some countries such as the Netherlands have designed their cities around the needs of cyclists and pedestrians (up to 70 percent of commuters are cyclists).

Ideas from the above-mentioned countries may well be relevant to developing countries, but it is likely that even more can be learned from good practice adopted by their Asian neighbors where perhaps more similar road and traffic conditions prevail. Some examples of such good practice, which may also be relevant to many other countries of the developing world, are mentioned below.

1) Several major cities have produced comprehensive studies covering their planning and transport needs. These include Guangzhou in the **PRC**, Yogyakarta in **Indonesia**, Rawalpindi in **Pakistan**, and Hanoi and Ho Chi Minh City in **Viet Nam**. All these studies included planning and traffic proposals to improve safety and, in particular, provide facilities for pedestrians, cyclists, other slow vehicles, and for public transport. These studies were financed by development banks and were produced with the help of local institutes and/or international consultants.

2) **Malaysia** has had some success in reducing motorcycle accidents by designing segregated motorcycle lanes alongside a freeway. This example, although of relatively high cost, may well have a lot to teach other countries in the region where the traffic and accident compositions are similar. In particular, a study has demonstrated that high standards of design must also be applied to motorcycle lanes to prevent collisions between motorcycles.

3) Road safety audits have recently been introduced in **Nepal** under a Road Maintenance Project funded by the Overseas Development Administration (ODA) of the UK. Audits have already been conducted on several aid-funded road improvement projects and a local safety audit manual has been produced. The Traffic and Engineering Safety Unit in the Department of Roads of Nepal has been given the responsibility for conducting safety audits on all major new road projects. The World Bank has recently financed a safety audit of a major highway in the **PRC** and is also introducing safety audits into its road rehabilitation program in **Bangladesh**. The ADB and World Bank have provided assistance in **Fiji**, **Papua New Guinea**, and **Philippines** to develop local procedures for safety audit.

4) Many countries have newly produced national standards for highway design, road markings, and signs. Many of these were similar to, and based on, American, Australian, or European standards, but with minor local variations. Some of these standards are, however, still in draft form and have been for a considerable period. Suitable standards are relatively easy to develop for any country but there is then the need to ensure they are adopted formally.

5) Many countries in the region have at least a few examples of facilities for bicycles and other nonmotorized vehicles. These are separate lanes either physically segregated or delineated by road markings. Where encroachment has been resisted, they are usually well-used and beneficial from the capacity and safety points of view. The **PRC** has perhaps more examples of this facility than other countries, but many other examples of good practice were observed in, for example, **Indonesia** and **Viet Nam** (see Plates 8, 9, and 10). References 5 and 6 provide more information on facilities available for nonmotorized and vulnerable road users.

Plate 11: Cycle lane on minor road, PRC.

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Road Safety Guidelines for the Asian and Pacific Region

The guidelines cover 14 individual sectors affecting road safety, with four introductory chapters and four appendices. Information is presented in a series of freestanding documents that can be extracted for distribution and discussion.

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3: Road Safety Action Plans and Programs
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Appendix B: International Contacts and Organizations
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