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**What are the tools for
managing speed?**

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THERE ARE many tools available for effective speed management. They include appropriate speed limits, engineering treatments, effective enforcement of speed limits by police and the use of extensive public information and education programmes to encourage compliance with both advisory speed signs and statutory speed limits.

In most cases a mix of tools is required to create solutions that are appropriate to the needs and capacities of the individual country. This module describes those tools available to influence speed. Six topics are covered in this module:

3.1 Speed zoning and speed limits: Speed limits that take into account the function of the road and its environment are a fundamental tool for speed management. Urban and rural settings, which have a different mix of traffic, require different approaches to achieve effective speed management. This section discusses ways to define a hierarchy of roads in accordance with their main function, and how to set appropriate speed limits for them.

3.2 Changing behaviour – regulating and enforcing speed: This section addresses the legislative and regulatory settings that provide the basis for speed compliance, and the various methods and techniques available for on-road enforcement. These include the use of fixed and mobile speed cameras, the tolerance in enforcement of speed limits by police and the importance of penalties such as fines, demerit points, licence suspensions and vehicle confiscations.

3.3 Changing behaviour – public education: The role of public education to improve compliance and support ongoing police enforcement activity is addressed in this section. The effectiveness of community-based programmes is also highlighted.

3.4 Engineering treatments: A range of measures is available to reduce speed in high-risk locations. For example, in locations of high pedestrian activity near schools, markets, shopping centres and busy urban precincts, measures such as speed humps, raised pavement sections and road narrowing are often highly cost-effective treatments.

3.5 Use of speed-limiting technology and intelligent speed adaptation: The use of speed-limiting technology – for example speed limiters and data recorders – for heavy and light vehicles is addressed in this section.

3.6 Speed management by employers: This section addresses the role of vehicle fleet operators in reinforcing speed compliance by employees.

3.1 Speed zoning and speed limits

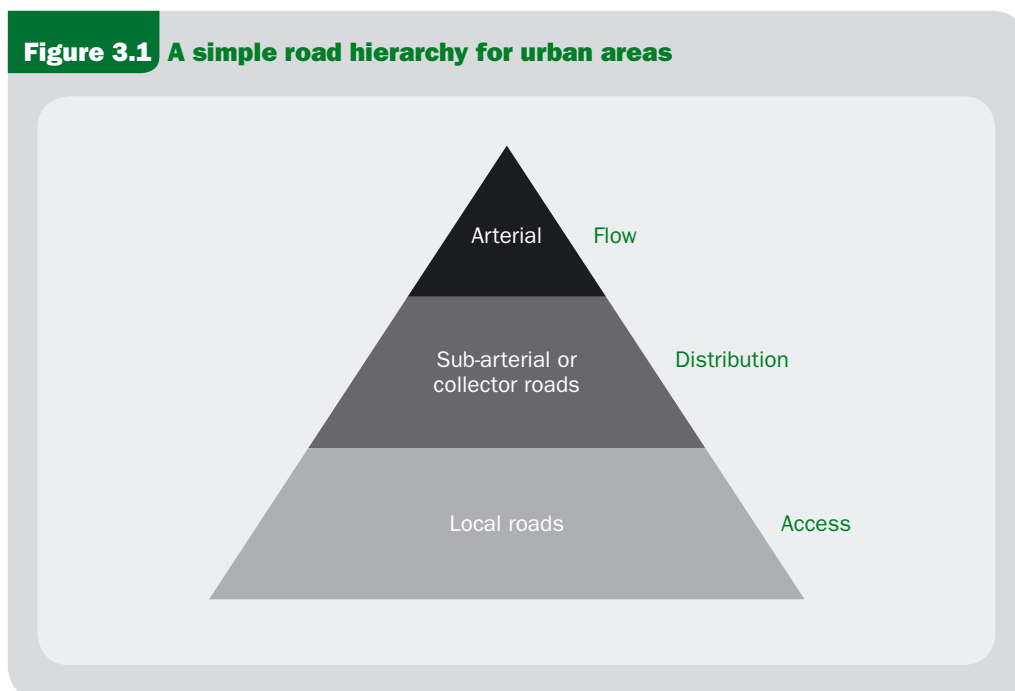
Road functions and hierarchies differ considerably between rural and urban areas. The nature of crash and injury severity risk also varies within these two broad groupings.

The classifying of each road by its particular function will reflect current use in most cases. A road's function within a hierarchy provides a basis for more consistent application of speed management across the road network, while recognizing that higher risk sections or routes will need different speed limits to respond to their relative risk. For example, areas around schools may require a lower speed limit because of the presence of child pedestrians. Classifying roads by function also enables identification of sections of the network where future engineering treatments might reduce crash risk, allowing speed limits to then be re-assessed.

3.1.1 Classifying roads by function and activity

It is valuable for long-term speed management to establish a hierarchy and function of road use for both the rural and urban network (see Figure 3.1).

Figure 3.1 A simple road hierarchy for urban areas



Considerations should include:

- population density
- road user density

- through traffic (arterial) or local traffic (access) and relative traffic flow
- road user mix – pedestrians, motorcycles, bicycles, animal-drawn vehicles, buses, trucks and cars
- ability to segregate road users
- adjacent footpaths, abutting developments
- roadside activity.

At the top of the hierarchy are roads that primarily cater for transport of people and goods over long distances through rural areas. Generally, higher speed limits are permitted on these arterial roads than are permitted on sub-arterial and local roads. At the other end of the hierarchy, local roads often accommodate a variety of functions and road user types, and are therefore usually assigned lower speed limits to ensure the safety of all road users (Box 3.1).

BOX 3.1: Consider the uses by all road user types

A road hierarchy needs to be based on road function and consider all road users, not just motorized traffic. It needs to be simple so that it can be understood both by those implementing it, and by road users. Typically, roads within a hierarchy will have a traffic function (primarily moving motorized vehicles over longer distances), a local function (mainly for short journeys, including those involving walking) or a mix of the two functions. Therefore, the simplest road hierarchies typically have three types of road for urban areas, and two or three for rural. Each of these road types should be linked to a specific speed limit. Roads with a traffic flow function have the highest speeds, while those with a local function have the lowest.

One simple way to rank a road within a hierarchy is by using a map. Strategic routes that mainly carry through-traffic can be marked as such. Roads with a local function can also be highlighted. The remaining roads can be marked as mixed function. Using a map, conflicts in the road network can easily be

seen. For instance, a road with a mainly traffic function that passes through a local road network may suffer conflicts between road users. Long-term planning will be required for this road to bypass the local road area, and until that time, its position within the hierarchy should be downgraded to a mixed function, with a speed limit and road infrastructure (such as separation of different road user groups) appropriate to that function.

Speed limits are an essential part of defining the hierarchy as a way of informing drivers of the appropriate speed and likely activities on the road. In some high-income countries, changes in infrastructure layout and design features are also used to create a 'self-explaining road', indicating to road users what type of road within the hierarchy they are travelling on. This is achieved using standard features on different types of road within the hierarchy (such as median barriers on roads for through traffic in rural areas), and by clearly marking the transition between different types of road.

Sometimes there are few roads suitable for high speeds in a country. However, there may be a small network of good-quality *arterial* roads in rural areas that have, for example, features such as wide, paved shoulders, median barriers, adequate clear zones, few access roads, good alignment, good intersection treatments and few vulnerable road users (for example, pedestrians needing to cross it to access goods or services).

In most instances, on lower quality rural roads – often the majority of the rural network – consideration of severe crash risk potential and adoption of a *Safe-system* approach will lead to speed limits that are unlikely to exceed 60 to 70 km/h.

In urban areas, a hierarchy should also be identified so that local streets can be clearly separated from sub-arterial (distributor and collector) roads, and from arterial roads. An acceptable speed limit for each category of road should be introduced, reflecting *Safe-system* principles.

It is good practice to identify road sections where functions are in transition from through roads to roads serving local traffic functions, such as highways entering and leaving towns. In this case, short sections with speeds between highway and town limits should be defined so that there is no sudden drop or rise in speed limit. For example, a highway speed of 90 km/h dropping to an urban limit of 50 km/h may have a section between at 70 km/h to help prepare drivers for the changed speed environment.

A review of road classifications should be done periodically, taking into account population growth, urbanization, traffic mix, number of vulnerable road users and other factors that change the nature of road use.

Rural arterial and local roads

On rural arterial roads, vehicles usually travel at higher speeds and the distances travelled are often substantial. However, there may be places where large numbers of vehicles enter or leave the carriageway, or where there are numerous intersections and roadside hazards, or where there



is a diverse mix of traffic, including vulnerable road users. Speed limits along these lengths of road should be lower, to reflect the increased risks resulting from the mix of functions and activities.

Local rural roads should be assigned lower speed limits that reflect their (usually) poorer quality. The presence of slow-moving vehicles such as tractors and other rural vehicles, cattle and other animals, as well as pedestrians makes it important to restrict travel speeds.

Urban arterial roads and local streets

Roads that form the ‘arteries’ for traffic flowing in and out of cities are described as urban arterials. If these roads are of a sufficiently high standard, and there is effective physical separation of vulnerable road users from through-vehicle traffic (with effective limitations on vehicle access to the road from abutting properties) then speed limits on these roads can be higher than on mixed-use urban local streets.

Speed limits on local urban streets should take into account the variety of functions of these streets. For example, school zones, shopping precincts and purely residential areas may have limits that ensure that young and vulnerable road users are not put at risk of serious injury. For these zones, limits as low as 20 km/h are appropriate. Merely posting lower limits will not ensure vulnerable users are not put at risk. The lower limits must be supported by the road layout and other appropriate measures.

Box 3.2 describes the impact of mixed user activity on a road hierarchy, and the need to prioritize pedestrians’ and other vulnerable road users’ safety above vehicle speeds.

BOX 3.2: Function-based road hierarchy

Roads in low-income countries can have a range of functions, including being a district distributor and transporting traffic throughout the city, to being an access road with houses and local amenities situated along it. This causes conflicts when attempting to develop Urban Safety Management techniques, and an adaptable approach may need to be sought.

Instead of an engineering-based road hierarchy, a function-based evaluation might be more appropriate in some countries, with land use being a key indicator of the road function and identifying whether this accords with the designated traffic function. This different approach would often give priority to pedestrians and those using the services situated along these roads as opposed to concentrating on vehicle needs and justifying safety measures to suit them.

In a number of countries, continuous segregated routes have been developed, linking areas of a town or city, which can also be considered part of the road hierarchy and have considerable potential for low-income countries. These include:

- **pedestrian routes:** include roadside footways, shared areas with other vehicles, footpaths or special pathways designed for shared pedestrian and cyclist use.



- **cycle routes:** include shared paths with pedestrians, separate cycle lanes on busy roads and separate cycle tracks.
- **motorcycle lanes:** purely dedicated to motorcycles in countries such as Malaysia and Indonesia which have very high usage of motorcycles.

Source: (1)

3.1.2 Speed zoning and speed limit reviews and guidelines

Beyond defining roads in a functional hierarchy, there are specific zones within each of the three levels of the hierarchy. For example, there are *transition zones* on arterials with a flow function as they approach a town, which may require slowing of traffic. Another example – this time with access roads in the local system – are *school zones* that require very low speed limits owing to the unpredictability of vulnerable pedestrian activities.

Establishing a consistent practice of limiting vehicle speeds on parts of road networks with similar functions and conditions assists drivers in developing good driving habits. Drivers come to understand and accept the need to limit their speed when entering certain types of area. Ideally, the areas will be *self-explaining* or somehow give visual clues to the drivers about the need to drive within the prescribed speed limits.

Setting speed limits is a primary tool of speed management. This can be done in three ways. These are:

- non-signposted general, or default, limits – which set the maximum speed allowed on specific roads such as motorways, or in urban areas
- signposted limits on roads or sections of roads
- speed limits for specific vehicle or road user types – e.g. farm vehicles, heavy transport vehicles, learner drivers.

It is possible to set variable speed limits that can be changed at high-risk times, for example, when road workers are present, or when children are travelling to and from school, or during adverse weather.

A comprehensive review of existing speed limits – and especially default limits – is a key step towards reducing unacceptable crash and injury risks (Box 3.3). This should include an assessment of new road construction standards or road works in progress.

BOX 3.3: Evaluating appropriate speeds using cost-benefit assessments

In 2000, Norway's Public Roads Administration attempted to define appropriate speeds on various types of roads in built-up areas. Speeds were assessed on the basis of the following cost elements:

- time costs for all road users
- operating costs for motor vehicles
- crash costs
- costs related to the feeling of danger
- costs related to noise from motor traffic
- costs related to local and global pollution.

On the basis of these elements the following appropriate speeds were defined:

- regional main roads: 60 km/h
- local main roads: 50 km/h
- distributor roads: 50 km/h
- access roads: 30 km/h
- roads in city centres: 30 km/h.

These figures are calculated from a scientific base. It is then up to the relevant authorities to define speed limits on the basis of these calculations.

Source: (2)

Some examples of speed limits applied on rural and urban roads in low-income countries are set out below. However, it is essential that limits adopted after a review in any country reflect the road safety risks applying in each part of the road network. Current general speed limits vary internationally, but most higher income countries follow a hierarchical approach and adopt speed limits within the levels indicated in Table 3.1 (3). The presence of pedestrians, two or three-wheelers, cyclists, farm vehicles and animal-drawn trailers using a road or street in substantial numbers, lower standard road geometry and unsafe roadside conditions will require lower limits than indicated in the table.

Table 3.1 Average speed limits in high-income countries

Urban roads	30–50 km/h
Main highways or rural roads	70–100 km/h
Motorways	90–130 km/h

The maximum speed limits in low- and middle-income countries vary widely from no limits at all to limits similar to high-income countries. Table 3.2 provides a sample of lower and middle-income countries' speed limits for rural and urban areas.

Table 3.2 Speed limits in urban and rural areas of selected lower and middle-income countries (not including motorways)

	Rural limit	Urban limit
Argentina	80–100 km/h	40–60 km/h
Kerala, India	70 km/h	40 km/h
Uttar Pradesh, India	No limit	No limit
Ghana	90 km/h	50 km/h
Indonesia	80–100 km/h	40–60 km/h
Malaysia	90 km/h	50 km/h
Nepal	No limit	No limit
Vietnam	40–60 km/h	30–40 km/h
Uganda	100 km/h	65 km/h

NOTE**Speed management on rural unsealed roads**

Unsealed roads present particular problems for regulating safe speed limits. This is because the conditions on these roads can vary significantly over time as a result of weather and other factors. Additionally, enforcement of speed limits is difficult on rural and remote roads. In this case, it may be best to influence selection of speeds by providing guidance about conditions or features that suggest that drivers need to use caution in their choice of speed. A simple way to do this is to use advisory signs that do not prescribe speed limits, because a fixed advisory speed may give a false impression about the speeds that are safe at the time of use.

**Speed limit guidelines**

Guidelines for setting limits can be derived from the application of *Safe-system* principles. These are important to consider when establishing an appropriate speed limit. The *Safe-system* approach advises that:

- if there are large numbers of vulnerable road users on a section of road they should not be exposed to motorized vehicles travelling at speeds exceeding 30 km/h
- car occupants should not be exposed to other motorized vehicles at intersections where right-angle, side-impact crashes are possible at speeds exceeding 50 km/h
- car occupants should not be exposed to oncoming traffic where their speed and that of the traffic travelling towards them, in each instance, exceeds 70 km/h, and there are no separating barriers between opposing flows
- if there are unshielded poles or other roadside hazards, the speed limits need to be reduced to 50 km/h or less.

Until recent years many countries have used the ‘common practice’ approach to speed limit setting described in Box 3.4.

BOX 3.4: Safety risk assessment instead of common practices

At minimum, “speed limits should reflect an appropriate balance between safety and mobility. Many countries set limits for a given section of road according to a range of criteria, including road characteristics, crash records and measured free speeds. However, there are indications that too much weight is sometimes given to measured

speeds (typically 85th percentile speeds) – based on the dubious assumption that most drivers make well-balanced speed choices – and not enough weight is given to objective assessments of risk (4).” It should however be noted that if the gap between the speed limit and the average speed is great, the limit will lack credibility and be difficult to enforce.

Increasingly countries are modifying speed limits to make safety the criterion to limit travel speeds.

Guidelines should consider the standard of road and the roadside, vehicle standards, the line of sight and visibility, road user mix and traffic volume. Existing guidelines for setting speed limits should be reviewed to ensure consistency. This achieves system integrity, leading to greater compliance of drivers (Box 3.5).

BOX 3.5: Factors to consider when setting speed limits

After considering guidelines based on achieving a *Safe-system* outcome, further local factors need to be considered in setting speed limits at particular locations.

- **Traffic mix** and the different types of vulnerable road user.
- **Crash history**, severity (injury) and crash rate (per vehicle kilometre of travel (vkt)) where possible. Road alignment (both vertically and horizontally). Crash prone stretches of road should have lower limits.
- **Road shoulder width and pavement quality** – narrow shoulder widths (especially those with poor pavement quality) can run an increased risk of ‘loss of control’ crashes. Therefore, speed limits should be lower for these conditions.
- Road **delineation** – edge and centre-line marking, reflectors and guideposts on the edge of shoulders and advisory speed limits. Where roads have poor visual definition, the speed limits should be lower to enable time for driver judgements.
- Road and **lane widths** should be adequate (i.e. at least two lanes with a minimum lane width of 3.4 metres). Narrow lane widths offer little margin of error and therefore speed limits must not exceed that required by drivers to keep consistently within a lane.
- The intensity of **land development abutting a carriageway** – in built-up areas, there is a dual risk of poor visibility and more varied activity of people and vehicles entering the road environment, and therefore speed limits should be lower.
- The type of **intersections** and the nature of traffic control measures at intersections. While all types of intersection present increased risk to road users – and roads other than motorways should have lower limits – poorly marked intersections require even lower speeds leading up to them than other, more clearly marked intersections or roundabouts.
- **Traffic volume and traffic flow** – lower speed limits in areas of high traffic volume can be used to smooth traffic flows, making for better network efficiency and environmental benefits, as well as improved safety.
- Types and standards of **vehicles allowed to access** – roadways that vulnerable road users such as cyclists are allowed to use should have lower limits than those that only allow four-wheeled (or above) motor vehicles.
- The **free travel speed** of the road.
- The ability to **overtake safely** (within sight distance) at the posted speed.



CASE STUDY: Setting speed limits in South Africa

A study of speed-limit setting practices in South Africa in 2000 found that speed limits were “inconsistent, leading to the perception among drivers that they are unfair, and that the sole purpose of the limits is to prosecute drivers to generate income and not to improve safety”.

This highlighted the need for all speed limits to be established by adequately qualified practitioners, and that a certificate be issued by such a person for each speed limit introduced. The study group also proposed that provincial and national governments institute Speed Limit Review Boards to oversee the process of establishing speed limits. Source: (5)

While consistency of limits in similar risk settings is highly desirable, substantial variations in existing crash and injury risk along sections of the network may require different limits to be applied, unless engineering measures can be taken in the short term to lower the risk. In the long term it is important that all measures complement each other, e.g. both speed limits and engineering measures should encourage drivers to use the same speed. If road layout and signs do not complement each other, the public will not trust the system and therefore not respect the law.

BOX 3.6: X-Limits – speed limit tools

Most Australian jurisdictions have adopted the use of an ‘expert’ computer system to assist setting of speed limits. The *XLIMITS* series, considers a variety of factors in the setting of speed limits, including road and road environment factors (road function, number of lanes, horizontal and vertical alignment, presence of a median or service road), abutting development, nature and level of road user activity (pedestrians, cyclists and heavy vehicles), crash history, existing operating speeds, traffic volumes and adjacent speed limits.

Certain basic information, or ‘determinant’ factors produce an initial speed limit value, while other

modifiers or ‘advisory’ factors highlight issues that require further consideration and that may alter the initial speed limit value.

The tool is based on extensive trials and input from an expert group. Versions have been provided for New South Wales, Victoria, Queensland, Western Australia, South Australia, Tasmania, New Zealand and the US, each tailored to meet local speed setting guidelines.

Further details on the *XLIMITS* system can be found in (6) and (7).

Finally, care needs to be exercised when introducing speed limits for the first time on a section of road where they have not previously existed, or to increase or decrease limits on an existing section of road. Studies have shown that mean speeds will increase if new limits are in excess of previous mean speeds. This will lead to increased fatalities and serious injuries on that section of road unless extensive targeted infrastructure safety works are carried out.

CASE STUDY: Effect on mean speeds of changed speed limits, Finland

A Finnish study examined the introduction of speed limits on rural roads that had previously had no limit. The report includes analysis of how limits related to initial free speeds that were not subject to posted limits or enforcement.

The research showed that setting limits:

- below the pre-existing 85th percentile free speed reduced later mean speeds
- above the pre-existing 85th percentile free speed increased later mean speeds
- at the pre-existing 85th percentile free speed did not change later mean speeds.

Injury crashes were reduced if (and only if) mean speeds were reduced (and increased if speeds increased).

Source: (8)

3.1.3 Informing drivers of limits – signs and default limit information

There will usually be an agreed general speed limit for higher standard rural and urban roads, and these are normally referred to as the ‘default’ speed limits. While these are usually not signposted, they should nevertheless be clear to existing and new drivers (including visitors) entering the road network. How they may vary should be indicated by specific signs.

Locations where alternative (to default) speed limits apply are usually depicted by regulatory speed limit signposting.

These limits may include:

- linear speed limits (including transition/buffer speed limits) i.e. along lengths of roads and streets
- shared road-space speed limits for combined pedestrian and vehicle use areas, usually less than 10 km/h
- area-wide residential or commercial speed limits, with signs at entry point to the designated area
- time based speed zones
 - ▷ *school speed zone* – usually twice daily time-based lower limits for an hour or so at school starting and finishing times
 - ▷ *seasonal speed zone* – for example at beach resorts in busier summer months when vehicular and pedestrian traffic is greater
- variable speed limits (limits that change under certain conditions or times of day). These are usually electronic signs with lower limits applying for example, in wet or windy conditions
- heavy vehicle speed limits. Regulations may specify a lower limit for heavy or light vehicles on roads in open rural areas and on roads in urban areas.

Where rural roads are of a very high engineering standard, with clear and protected roadsides and limited potential for conflict with vulnerable road users or vehicles entering from the roadside, a higher limit may be appropriate. In such cases, adequate signs are needed to make it clear that the default limit does not apply. It is important that speed limit signs are provided at the end of that higher speed length where the speed limit reverts to the default limit. For sections of road where the default limit is considered too high and would provide an unsatisfactorily high road safety risk, lower limits may be called for. Regular signs are also essential at the beginning of the lower speed limit section, and at intervals along the length of that section.

As an example, repeater signs every 400 metres from the initial speed limit change could be considered a minimum standard in urban environments where the default limit does not apply. The signs should reflect international good practice, should be distinguished from other statutory and advisory signs and from other visual roadside clutter.

Signs and markings should follow the Vienna Convention (www.unece.org/trans/roadsafe/rsabout.html). This convention provides international consistency and enables drivers from other jurisdictions to more readily understand them.

Signs and road markings can be costly, but are crucial. Speed limit signs should be produced using material that is reflective, especially for sections of road that are not well lit at night. At points where speed limits change it is good practice to mark the limit with paint on all lanes of the roadway. While electronic, variable speed limit signs are more costly, they can be cost effective on high-traffic routes, or in areas where there are particularly important road safety risks to address, such as in school zones.

In rural areas, speed limit signs should be repeated at least every 5 km along the length of road where the default limit does not apply and the conditions are reasonably consistent.

It is not recommended that varying differential speed limits apply to different categories of vehicle on a section of road. This would create the opportunity for substantial turbulence within traffic and may increase the frequency of overtaking manoeuvres, which can in themselves lead to increased crash risk. If there is to be a lower limit – for example, for heavy vehicles – it is suggested that this is a consistent amount below general limits, whether default or signed, on all rural roads. Speed differential is a major cause of crash risk on higher speed roads.

Advisory speed warning signs

Advisory speed signs may be used with a warning sign where the safe speed is lower than the applicable speed limit (Box 3.7). This applies to weather, traffic and road conditions to provide for safe travel through the hazard (e.g. horizontal and vertical curves). Advisory speed signs are not generally recommended for unsealed roads, as it cannot be reasonably assumed that the advisory speed will remain the same and that the road will not be subjected to major changes in surface condition as a result of weather and wear. In these situations an appropriate hazard warning sign is more appropriate.



If these warning signs and advisory speed are to be used, it is important that they are consistent in their application and in the advice they give, particularly in relation to safe speed. Inconsistent application may well increase risk, rather than achieving an overall reduction in risk.

BOX 3.7: Unsafe but legal travel speeds

Advisory speed signs are often used on sections of road where the safe travel speed is below the applicable speed limit, such as tight curves.

Drivers of cars and heavier vehicles will usually observe this advice (or at least be alerted to the hazard) as it is often not feasible for some vehicles to negotiate the curve at a higher speed. However, for two-wheelers, it will very often be possible to travel

through the bend at a higher speed than is advised or safe, but which is within the statutory limit.

It is always the responsibility of the driver to drive in accordance with the conditions. However there is always a need to consider whether limits on sections of a curving road should be lowered, rather than placing reliance on compliance with advisory signs.

3.2 Changing behaviour – regulating and enforcing speed

Establishing a clear legal framework for managing speed is a fundamental requirement for achieving compliance with speed limits. Traffic laws, enforcement strategies and resources, as well as effective and efficient mechanisms to administer penalties, are needed for this task.

3.2.1 Road rules, legislative and regulatory settings

Road rules or highway or traffic regulations that set out the framework for behaviour of road users are most often authorized by the relevant Transport or Road Safety Act. A road rule can specify that a driver must not drive over the designated speed limit on a length of road (and define the various penalties for different levels of non-compliance).

In road rules in most jurisdictions, it is the presence of signs that imposes the legal obligation for compliance.

Signs, in accordance with the road rules, should specify where the speed limit starts and finishes – for example when a speed limit sign with a different number is observed further along the road, or the road ends at a T-intersection or dead end, or a speed de-restriction sign has been installed at a point on the road. Other provisions for the establishment of, and compliance with, speed management instruments such as school speed zones, speed limited areas and speed limits in shared zones (as well as general, default speed limits applying across urban and/or rural areas in each country) should be specified in road rules. The form and appearance of speed limit signs and special signs such as area-based speed limits, shared zone speed limits or school zone speed limit signs (where applicable) should also be described and published in the road rules.

It is essential that new or amended legislation and regulation clearly require compliance with speed limits and provides for enforcement of those limits by police through a variety of means, including automated camera enforcement. In most jurisdictions, legislative power is necessary to use automated enforcement in various ways, such as mobile and fixed speed cameras, as well as police operated hand-held or car-mounted speed detection devices. Laser and radar speed measuring devices are generally accurate to within ± 2 km/h and ± 3 km/h respectively. In enforcement operations it will only be possible to prosecute a driver for a measured speed that exceeds the limit by more than the tolerance.

Subordinate regulations are usually required to specify the type of technology, validation procedures and the chain of evidence that is to be applied from the point of offence to the payment of the fine or subsequent court processes.

It is advisable that the level at which police will penalize a driver for exceeding the limit, known as the enforcement tolerance, is not set too high. In a number of jurisdictions, police have reduced the allowable tolerance from 10 km/h above the speed limit to a level approaching the equipment tolerance of 3 km/h above the speed limit. Evidence shows that the reduction in free speeds and in fatalities – especially vulnerable road user fatalities – as a result of this have been substantial (2).



3.2.2 Speed enforcement methods

A number of police forces internationally have adopted enforcement methods based upon an *anywhere, anytime* approach to deter all speeding on the network (Box 3.8). The message is clear: speeding is illegal and unacceptable behaviour, and at odds with the interests of the community.

BOX 3.8: Specific and general deterrence

How speed enforcement is done determines whether its principal effect is through *specific* or *general* deterrence.

- Operating highly visible (police or fixed camera) speed enforcement in the same areas all the time is likely to result in drivers being deterred from speeding only in those **specific** areas.
- Operating a mix of highly visible and strategically directed police patrols or speed cameras

increases public perception that speed enforcement can happen anywhere and at any time. The unpredictability of where and when speed enforcement operations take place will have a more **general** deterrent effect by encouraging drivers to drive within the speed limit no matter where or when they are travelling. An example is shown in Appendix 2.

Convincing the public of this can be difficult. It usually depends upon substantial resources for mobile police or mobile camera deployment, supplemented with fixed cameras at high risk locations. It will also be dependent upon extensive public advertising to increase the perception that widespread enforcement is taking place.

In routine patrols, speed checks are commonly undertaken with a police vehicle maintaining the same distance behind the offending vehicle over a distance of at least 200–300 metres, and checking the speed on the police vehicle's speedometer.

Time over distance in vehicle speed measuring devices provides an effective and indisputable speed measurement in either urban or rural areas. These instruments are set by the police officer when the speeding vehicle is first observed and followed, to just prior to the point of interception when the instrument is again triggered. This method uses both the police speedometer and the odometer to provide the average speed over the observed distance. It provides a fairer assessment of the offender's speed, eliminating excuses of 'just passing another vehicle', 'keeping up with the traffic', or 'I only speed for a short distance'.

Two parallel pneumatic tubes affixed across the roadway – see Section 2.2.2 – can be used to measure time over distance for an accurate speed calculation with a police colleague at a safe interception point a few hundred metres further on. In most jurisdictions these have been superseded by radar or laser equipment.

Speed estimates are also acceptable in some jurisdictions where a speeding vehicle may pass a marked or unmarked police vehicle (here, there is a comparative speed measurement). The driving and traffic patrol experience of the police officer may be used to substantiate an estimate of the vehicle speed, coupled with the offender's explanation for the errant behaviour. In some countries it is the police officer's opinion which is the primary evidence and the equipment is the secondary (Box 3.9).

BOX 3.9: **Evidential requirements**

In all cases, the burden of proving the actual speed and linking the speed to the offending driver rests with the police. Evidence will include:

- the identity of the driver
- evidence of the speed limit
- verifiable evidence of the speed alleged, including visual observations
- the type of equipment used
- the fact that the equipment was certified as accurate (by a secondary speed measurement device verified periodically)
- any explanation offered by the driver (not essential)
- environmental conditions e.g. traffic, weather and road conditions (relevant although not essential).

At a very basic level, using stopwatches to measure the speed between two points on a section of road which are a known, accurately measured distance apart, can be a useful form of speed enforcement. The distance can be between lines marked on the roadway or between two fixed objects in the environmental setting.

Certification of equipment accuracy may be carried out by independent laboratory testing or through police workshop technicians, reflecting the processes accepted by regulation or policy. Whatever the process, it must be able to be verified as evidence in a court of law.

Evidence of identity is not always required with speed camera technology. In some jurisdictions owner-onus legislation applies, i.e. the owner of the vehicle is liable unless s/he provides a declaration naming the offending driver at the time of the alleged offence. Some jurisdictions require a photograph of the driver; however, this does limit camera effectiveness as a deterrent.

Where camera-based operations cannot be introduced in the short term, effective compliance can be achieved (particularly in urban areas) with widespread use of hand-held radar or laser devices, coupled with normal traffic patrols and relevant interception strategies. The visibility of police operating to ensure speed compliance is often far more effective than issuing traffic infringements or tickets. Behavioural change will occur when the public perceive there is a high risk of being detected speeding, and that detection will lead to a penalty.

Equipment can later be upgraded to car-mounted, mobile radar devices and in-car video equipment which now provides the most up-to-date, high-impact police enforcement tool for traffic offenders.



CASE STUDY: **Intensifying enforcement and penalties to improve rule compliance, France**

The intensification of enforcement and penalties was achieved through introduction of automatic enforcement and penalty systems for speed violations. In November 2003, the first speed cameras were installed across the country. At the end of 2004 there were 400 speed cameras (232 fixed and 168 mobile) and by the end of 2007, there are to be 2,000 systems in operation (including fixed and mobile cameras). Around 75% of cameras are in rural areas and 25% in urban areas.

The enforcement process is now fully automated. The penalty system was modified, with minor offences having fixed fines, and more serious offences having greater fines. Overall, detection rates have increased and sanctions are more severe for repeat offenders.

The results have been very positive. Fatal and injury crashes decreased in the vicinity (6 km) of fixed cameras by 40 to 65%.

Average speed on French roads decreased by 5 km/h over three years. The rate of excessive speeding (more than 30 km/h over the limit) was reduced by a factor of five.

Between 2002 and 2005, fatalities decreased by over 30% in France – an unprecedented result. These substantial decreases are not entirely due to the implementation of automatic speed controls, but it is estimated that the decrease in speed, in which automatic speed control played the major role, accounted for roughly 75% of this decrease.

Source: (2)

The use of speed cameras can be a cost-effective speed management tool. It provides consistency of enforcement, reduces individual police discretion and removes point of interception collection of penalties. This reduces the potential for corrupt enforcement practices.



CASE STUDY: **Speed cameras in Santo André, Brazil**

In Santo André, the town council implemented a general road safety programme that included electronic enforcement using radar systems. Information on factors such as traffic flow, crash rates and road function were used to identify suitable camera locations. Installation of equipment was preceded by media publicity and the use of roadside banners to make the public aware of the safety benefits of speed management. Counter-campaigns were initiated by

some driver and political groups in opposition to the programme. Despite such problems the campaign continued and expanded. The first year resulted in a reduction of 8.6% in crash fatalities (compared to the previous year) while the second and third years produced further reductions of 17.6 and 25.7% respectively. A similar programme conducted in Sumaré also resulted in significant crash and injury reductions.

Covert or overt use of cameras

A highly effective speed management strategy involves speed camera operations combining both fixed site and mobile (vehicle-based) camera operations. Fixed cameras, although usually readily observed or soon identified by drivers, provide a strong message that speeding will not be tolerated and visible controls are in place. As a complementary strategy, the use of covert mobile cameras, particularly in urban areas, has been proven to be highly effective in conveying the message to drivers that speeding is illegal and not permitted anywhere or anytime (9). The mix is very effective in reducing average travel speeds on major sections of the network – in some cases to below the applicable speed limits.

Fixed cameras are another useful measure for addressing speed related crash risk at a particular location on the network. They tend to operate as a blackspot treatment with measureable effects upon crashes at the locations where they are placed. However, there is little evidence that they have an impact on crash reduction on the rest of the network except for a small 'halo' effect stretching a few kilometres from the camera site.



Preconditions for introduction of effective automated enforcement systems

There are a number of substantial constraints on adopting an automated speed enforcement programme (Box 3.10). Adequate administrative systems are needed in a number of critical areas before these programmes can be implemented.

BOX 3.10: Support requirements necessary for automated camera enforcement of speed limits

- Reliable camera technology, including accurate speed measuring equipment, clarity of image capture and effective maintenance programmes.
- A reliable postal (and property address) system for the whole jurisdiction.
- Reliable and comprehensive, computer-based driver licensing and vehicle registration systems.
- Regular and accurate data capture, verification processes and transfer by police and the court system to licensing and vehicle registration databases.
- An effective back-office processing system, including issue of infringement notice and follow up procedures for collection of unpaid fines from defaulters.
- A system for preventing the vandalising of equipment.

3.2.3 Penalties – fines, demerit points and licence suspensions

For effective deterrence it is essential that legal penalties are set at a sufficient level of severity (10). The levels of fines and/or demerit points incurred towards licence suspension should escalate as the level of speeding above a speed limit increases. The introduction of effectively applied demerit point systems in many countries has been accompanied by substantial reductions in road trauma.



CASE STUDY: Demerit point increases and effects, New South Wales, Australia

In an effort to give more effect to its speed management programme, the New South Wales regional government conducted a trial of doubling the demerit penalties for speeding offences in 1999. Over the 45-day 'holiday period only' trial involving publicity about the penalty and enhanced enforcement, the outcomes included:

- a decrease of between 27–34% in fatal crashes
- a decrease of between 27–30% in road fatalities
- an estimated \$1 million worth of additional media support
- high levels of community awareness and support
- reductions in traffic infringements.

Source: (11)

When appropriate regard is given to the risks associated with small increases in speeds above speed limits, it is important that the level of penalties for various levels of speeding reflect the relative risk to human life that the particular level of speeding poses. Licence suspension (and for very high speeds, licence cancellation) can be an effective deterrent against speeding, and in some countries immediate licence loss can take place when drivers are caught travelling at 25 km/h or more above the speed limit. Other penalties such as vehicle impoundment or confiscation for extreme or repetitive speeding may also be effective deterrents.

It is also critical that where licence sanctions are imposed – such as suspensions, disqualifications or cancellations – police and licensing authorities have the ability to ensure that these sanctions are rigorously enforced.

Penalties for non-compliance with speed limits

Various methods can be used to enforce the law.

- **Warning notices** can be issued in the time between any new law being passed and its full implementation. These notices inform drivers and riders that they have committed an offence under the new law, and that in the future a penalty will be imposed for breaking it.
- **Fixed penalties** can be issued with a written infringement or violation handed out on-the-spot, requiring the offending driver or rider to pay a fine to a given department (which can be separate from the police department) by a specified date (Figure 3.2).

To operate this method effectively, a computerized database should be set up to record all offences.

On-the-spot fines are levied in some countries. These are where speeding drivers or riders can be issued with an immediate infringement notice requiring the payment of a fine. Such systems should be upgraded immediately to ensure that no money transactions occur at the interception point, and a full audit of any financial transactions is maintained. This will minimize allegations of bribery, corruption and favouritism.

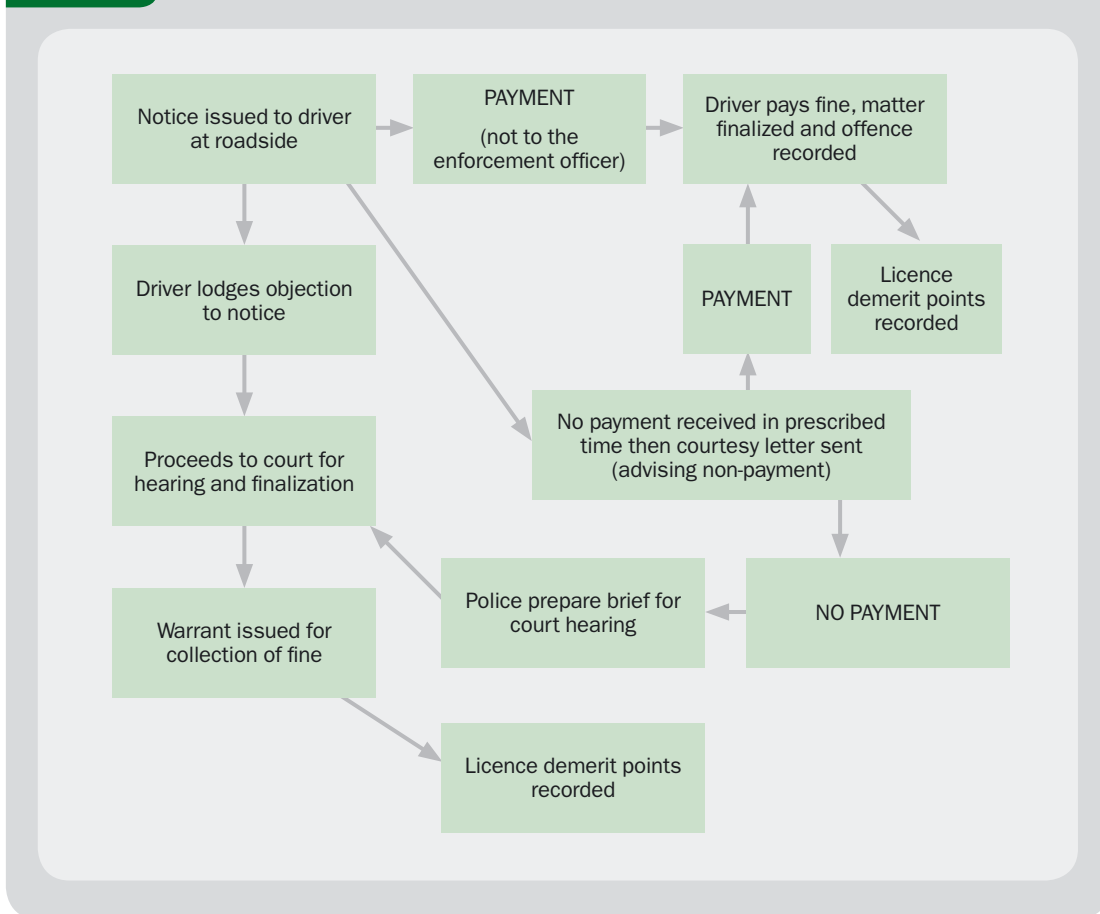
Confiscation of licences or of vehicles can be applied for serious speed offences as a blanket rule, or to repeat offenders. However, such measures are usually implemented only after other measures have been tried and found to be unsuccessful.

Demerit or black-point systems seek to deter drivers from continuing to re-offend for a range of road-law related offences. Countries without such a scheme should consider one. These schemes require the licensing authority to maintain accurate records with regard to all individuals holding licences so that each conviction for an offence reported can be recorded and attributed to the correct person. Demerit points are a form of penalty imposed when particular traffic offences are committed. When issued with a learner permit/driver licence, each driver has no demerit points.

Demerit points accumulate if a driver commits an offence that carries demerit points. A fine will often be imposed together with demerit points. Demerit points remain valid for a number of years (often three years) and the legislation specifies sanctions which are imposed when the number of 'points' reaches a particular level – e.g. cancellation of a licence with 12 or more points.

For additional examples of penalties applied to speed offences, see Appendix 3.

Figure 3.2 Process for handling fixed penalty notices and demerit point allocation



3.3 Changing behaviour – public education

Research and evaluation studies present mixed findings about links between extensive public education and the risks associated with speeding, and subsequent changes in driver speed behaviour (12). The general conclusion is that mass media road safety campaigns can change knowledge and attitudes but there is limited evidence that they change behaviour in the absence of accompanying enforcement.

However, while acknowledging enforcement is essential, there are good reasons to carry out public education about the risks associated with speeding and the benefits associated with reducing mean travel speeds on any section of road or street.

3.3.1 Social marketing and public education

The objectives of speed management campaigns may sometimes be to win greater public support for measures that will have an impact on individual road user behaviour, such as legislation, stronger penalties, more enforcement or road/traffic engineering changes. In other words, the aim is to *create a demand for speed management*. This will make it easier for governments to act by reducing some of the community resistance that they might otherwise encounter.

It is important to realize that while conveying dramatically the sometimes devastating harm of a speed related road crash usually does not change individual driver behaviour, it can serve as a *call to action*, or a way to draw attention to an important injury threat in the community. Using advertising to influence people emotionally can assist in persuading them that there is an important problem to address. When the community is convinced that the issue of speeding is an important one to understand, they will then be prepared to learn more about it and support actions to reduce the problem.

In Modules 1 and 2 the link between small increments in speed and increased risk of fatal crash involvement was discussed. This information can be conveyed to the public over time using mechanisms that are in accord with local customs and supported in a variety of ways to achieve broad awareness of the message and its seriousness. The community needs to understand why speed compliance is being sought, what the benefits are and why it is necessary for them to modify their behaviour.

It may be best to start public information campaigns about speed with less controversial issues such as increased crash severity caused by excessive speed. Another less-disputed topic that the community is often interested to know about is differential stopping distances required under different speeds, weather and road surface conditions.

There is also a case for using publicity to inform the public in advance of increased levels of enforcement in order to avoid adverse reactions against the police. This is particularly the case where laws are changing – for example if a new, lower, speed limit is to be introduced.



CASE STUDY: **An evaluation of the effectiveness of televised road safety messages, Ghana**

The effectiveness of televised advertisements conducted by the National Road Safety Commission in Ghana was evaluated in 2005. The advertisements concerned speeding and alcohol-impaired driving and were targeted at commercial drivers. Focus group discussions were conducted with 50 commercial drivers in four cities. Discussions addressed coverage, clarity and appropriateness of messages, including suggestions for improvements.

Most contributors indicated that the messages were clear and appropriate. Television reached all participants in this urban group. However, they felt that other modes of communication, such as flyers and radio, should also be used to reach drivers who did not own televisions. A particular problem was language. The advertisements had been in English

and Akan (the most common vernacular language). Participants wanted the messages diversified into more of the major Ghanaian languages.

Some participants were unclear on the behaviour that the advertisements were telling viewers to take. Participants advocated greater involvement by police in road safety. The advertisements reached and were understood by most of the target audience. Opportunities for strengthening the messages included using other media, increasing the number of languages, and stressing the change in behaviour being recommended. Overall road safety would be strengthened by increasing accompanying law enforcement activities related to speed and alcohol-impaired driving.

Source: (13)

Public figures as role models

In any campaign where government is seeking to change often deeply embedded behaviour (such as speeding) in a substantial proportion of the driving population, it is useful to seek to obtain the agreement of politicians, senior public officials, police and road authority staff to comply with speed limits in their driving tasks – and not only with work-related driving. Having ‘opinion leaders’ and celebrities to support speed campaigns can be very useful in getting public support.

It is unhelpful if public officials or politicians are known to be flouting the law. Obtaining their commitment to respect speed limits is also a very interesting way to assess underlying government support for behavioural change. It will be a barometer of their preparedness to identify with the changes being sought.

3.3.2 Increasing public perception of being detected by police

In some countries, being detected by police and charged with an offence is more likely than having a serious crash. To the individual, the risk of being caught and penalized is thus more likely to influence their choice of speed than fear of a crash. Perception of speed enforcement is a much stronger behavioural influence than messages about the injury risk of speeding.

Research indicates that combining specific public education campaigns with visible enforcement of speed can result in measurable reductions in speed related crashes (14). Advertisements in the media that serve to increase the perception that drivers

not complying with speed limits will be detected – and if detected, sufficiently punished – are likely to deter that behaviour.

3.3.3 Speed compliance incentives

Some countries have introduced incentives (although these tend to be small) for drivers to comply with limits (and other road laws). The potential benefit is improved public acceptance of tougher speed enforcement. One scheme in operation in Victoria, Australia, provides a 30% rebate on licence renewal for drivers with no offences (for any road laws) in the prior three years.

The benefits in terms of crash reduction are unknown and expected to be minor, but it is recognition, albeit in a small way, by government of those drivers who have not infringed and an offset – in political terms – to stringent enforcement of compliance. Such ‘carrots’ (rewards) can be effective in supporting the more common ‘stick’ (punishments) approaches.

NOTE

A word on driver training...

Post-licence, off-road driver training is usually not effective in reducing risk. Researchers believe that this is because additional training to increase driving skill tends to lead to higher risk driving because of a belief that faster speeds can be driven with enhanced driving skills.

Source: (15)

3.3.4 Community-based programmes

Sometimes people in local communities are motivated to take action themselves to reduce problems associated with speeding. These actions can range from community-based education initiatives, community members constructing speed humps or other traffic slowing devices in the roadway, or retribution directed at drivers who kill or injure people when driving too fast through towns.

This kind of community activity shows concern about the problem, but can create additional problems if not guided by road safety expertise. However, gaining community involvement in road safety and speed management is an effective means of influencing road users in a way that government agencies alone cannot achieve. Voluntary community work can also help to offset the costs of speed management programmes.



CASE STUDY: **Community involvement in speed enforcement, Thailand**

In Thailand, many rural communities are faced with drivers driving fast or in an impaired condition through their villages, and crashes involving villagers are frequent. The drivers/riders are often young and male.

In Khon Kaen province in the north-east of Thailand a number of community groups could no longer tolerate this behaviour and went together to the district police office to ask for help. The police were eager to help but could not see how it was possible to strengthen traffic law enforcement in these very rural and spread-out communities.

A special initiative was set up and villagers were trained to take action with (police) authority. Uniforms were provided to support this. The volunteers cannot enforce laws but have radios so they can call the 'real' police in case of trouble.

The police support the programme for two reasons. For a little investment, they get better compliance outreach, but also achieve better understanding by the public of their role in enforcing the law for the benefit of the community.

Thai villages are commonly set out in similar ways, with village gates at both ends of the village; this helps with monitoring the vehicles entering or

leaving. At the gate there is often a little hut where the volunteer can sit. Where the volunteers note speeding, or believe drivers or riders may be under the influence of alcohol or other drugs, they would talk to the drivers, explaining to them the requirement to behave lawfully and responsibly.

The programme was introduced in 2005 and 35 villages participated with 350 volunteers (ten per village), of which 200 are women. The volunteers have been selected by the villages themselves and no payment is received by them. Since the introduction there has been a reported 50% reduction in both road injuries and fatalities.



3.3.5 Licensing and speed restrictions

It is extremely important when learning to drive that new drivers learn to drive at the right speed for the prevailing conditions. Even when no obvious limits or clear engineering measures are present, drivers are expected to be able to adjust speed according to the environment. For example, in Malaysia, speed management is part of the driving curriculum.

New drivers rarely have a good sense of relative speeds and some may be a little over-confident. To cover this, some jurisdictions license new drivers in stages. When drivers are starting to learn, they are sometimes required to have a licensed driver with them while driving and to drive at speed limits set lower than the limits for fully licensed drivers. Sometimes, there are one or two additional levels of provisional licence that new drivers must pass through before finally receiving a full licence, each with speed restrictions and sometimes restrictions on the number of demerit points they may receive without losing their licence.

3.4 Engineering treatments

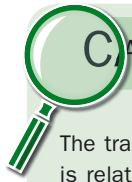
There is a large range of engineering treatments that have been shown to be of varying use in speed management. These measures are described in significant detail in various manuals and text books, and we do not intend to repeat all this information here – recommended references are (1, 16–22). However, a broad overview of available treatments is given below. A number of case studies which are known to have been effective in addressing speed are provided.

These treatments include engineering or re-engineering the road to encourage lower speeds, or make the road and its environment more forgiving or ‘self-explaining’. There are also treatments that aim to separate road users, particularly vulnerable road users such as pedestrians and two-wheeled vehicles, from potential collisions that could cause injury.

3.4.1 Treatments to slow down motor vehicles

There are a range of physical features that have been developed by road safety and traffic management engineers that encourage, or force, drivers to drive more slowly. Many of these treatments have the effect of making it feel uncomfortable to drive in excess of the legal or recommended speed. Some examples are raised humps or platforms across the roadway, road narrowings or ‘pinch points’, roundabouts, road markings, signs and physical structures that signal to drivers that conditions are changed such that they should slow down. In addition, fixed speed cameras can sometimes be used as an alternative traffic calming or traffic slowing device.





CASE STUDY: **Raised area (trapezoidal hump) in Tamale, Ghana**

The trapezoidal hump is made in concrete, which is relatively easy to manage during construction. The height is 10 cm and the ramp on each side is 1 m long, corresponding to a gradient of 1:10. The length of the flat area is about 7 m. It should be at least 4 m, and at least 7 m, on roads with bus traffic. These properties aim at a desired vehicle speed of 30 km/h for cars and 10 km/h for buses and other heavy vehicles. The ramps can be extended to 1.7 m for a desired speed of 40 km/h (20 km/h for heavy vehicles) and 2.5 m for 50 km/h (30 km/h for heavy vehicles). However, the height is always 10 cm.

Signs and markings

Drivers are properly warned in advance to lower their speeds. This is done with painted black and yellow stripes on the ramps, and hump warning signs ahead of the humps. Street light is also considered important although this is sometimes a problem in practice in Ghana. It should also be noticed that the speed limit around the humps, ideally, should be changed to the desired speed of 30 km/h.

Impact

Speeds have clearly been lowered and vulnerable road users find it easier and safer to cross at the location after the construction of the raised areas. However, a more comprehensive impact assessment is yet to be done.



The two raised areas are staggered on each side of the central island to slow vehicles down before the zebra crossings.



Illustration of the cross section of a raised area in concrete, 10 cm high and with 1 m long ramps for desired speed (30 km/h).

Speed humps and raised platforms at pedestrian crossing locations and at intersections

Single raised structures in the roadway (such as speed humps) are effective, especially in urban road environments. However, more lengthy sections of raised materials that affect drivers with audio and tactile signals when driving over them can be good options for slowing high speed traffic on the lead up to a changed traffic condition, such as an intersection that follows a lengthy stretch of a higher speed road. These are sometimes called 'rumble strips'.



CASE STUDY: Speed control using speed humps on intersection feeder roads, China

The speed hump is an effective speed reduction measure, placed across the road with a profile a little higher than the road surface. It is usually constructed of bituminous concrete, cement concrete or rubber.

Its vertical cross section can be semi-circular or parabolic. Its dimensions should be designed to ensure the safety of vehicles crossing it. At each end of the hump, near the kerb, the treatment should ensure that road drainage is not impeded. On a road section with speed humps, clear signs or markings should be placed to warn drivers, and the hump would usually be painted with reflective markings.

Speed humps force speeding drivers to slow down before intersections. When an emergency occurs, braking at lower speeds will reduce collisions with vehicles on intersecting roads. The speed hump is an effective speed reduction measure, with low project cost and high practical benefit. It has been broadly applied on national intersections with visible implementation effect.

Condition of road sections where speed humps were placed

The section from Taicheng to Guanghai of the Jingguang Line Road in Guang Dong province is a typical secondary road with many small intersections. There are 63 intersections with local country roads in a 40 km stretch. Minor intersections, without clear characteristics, are often blind spots for drivers on arterial roads; in addition, local road users often lack safety consciousness and it is very common to see tractors, motorcycles and pedestrians not correctly

assessing the higher speed of vehicles on the main road, resulting in numerous traffic accidents. In 2004, 14 people were killed in traffic accidents on this section of road, and minor intersection risks were identified as the main road safety problem.

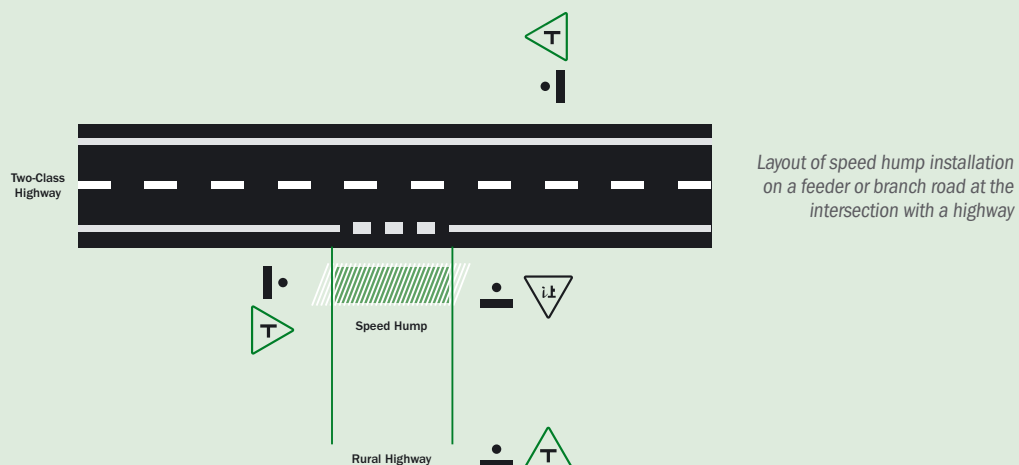
Scheme of implementation

In December 2004, intersections along this stretch were improved. Signs alerting drivers of the presence and location of intersections with minor roads were set up. Speed humps made of concrete were constructed on the branch roads (prior to intersections with main roads) to slow approaching vehicles. The speed humps are 450 cm long and 36 cm wide, and the height above the road surface is 6 cm. The vertical cross-section of the hump is trapezoidal in shape. The surface of the speed humps has been painted with yellow and dark reflective lacquer. 'Slow down' signs have been set up in advance of the humps to attract the attention of drivers.

Effect of implementation

Since installation of speed humps at small intersections along the route, crashes have reduced substantially.

Speed humps are also being used to control speed on lower classification roads in other areas and provinces, and are also proving effective. For example, in the city of Puyang in Henan province, speed humps were installed on a number of lesser roads intersecting with highways in May 2004. The number of crashes at the intersections declined, with the number of fatalities reducing by 61% compared with 2003.





CASE STUDY: **Rumble strips at high speed junctions, Ghana**

A heavily used junction located on a main highway in Ghana used to be a notorious spot for road crashes. In 1999 engineers installed a series of rumble strips on the approaches to the junction. They were created using hot thermoplastic road marking material, and each strip was 500 mm wide, covering the full width of the road. They had a rounded profile and at the time of installation the crest was 25 mm high. Drivers were warned by means of upright signs.

A 'before and after' study undertaken by the Building and Road Research Institute found that the annual number of crashes fell by 35% after the

speed management treatment. Observations of the behaviour of drivers at the site some time after the treatment revealed that a few car drivers were still speeding, perhaps because the strips had become worn down by the traffic to the extent that they no longer caused noise and discomfort when crossed at speed. It is clear that the design and maintenance of the rumble strip's profile may be critical for success.

Source: (23)

For additional illustrations of 'traffic calming' treatments tried in Ghana, see Appendix 4.

Gateway treatment at entrances to towns and villages

Gateways are devices used to mark a threshold – usually to a village or higher risk location on the road – where lower speeds are required from drivers.

Gateways rely on highly visible vertical treatments to capture driver/rider attention and usually include:

- large signs conveying the message that it is an entry to a location where pedestrians and other vulnerable road users are about to be encountered in greater numbers
- pavement markings to narrow the perceived width of carriageway, including painted central medians for a short distance at least
- large speed limit signs showing the lower speed limit that applies
- other pavement markings to indicate clearly that a threshold is being crossed into a different environment
- architectural and rural treatments such as picket fencing or gates, earth mounds and rock walls.



Markings can also be used to indicate an approach to a pedestrian crossing, or other changed traffic conditions where drivers should slow their vehicles in the interest of safety. A simple white jagged line as a centre line plus zig-zag lines on the edge of the lane, on both the approach and departure side of the crossing, can be used (and suitably promoted) to warn drivers that they are approaching a crossing.



CASE STUDY: **Speed management on rehabilitated roads through villages, Fiji**

It is frequently the case that road improvement and rehabilitation schemes carried out in low and middle-income countries result in more traffic, increased speeds and more crashes. There is a particular safety problem when such roads pass through villages and special measures may be necessary to reduce speeds and improve safety.

A method widely adopted in Fiji for villages along major roads (and also used in other countries) aims to gradually bring speeds down from the national limit to around 30–50 km/h as the traffic passes through. On the approach to a village, advance warning rumble strips on the road can be used to indicate a community ahead. A 'gateway' or threshold marker (e.g. a village sign on each side of the road) deliberately create the appearance of a road narrowing.

Similarly, a coloured section of road surface that creates a 'threshold' in combination with a small road hump can form a village 'boundary' to give clear demarcation, and informs the driver that an urban or speed-managed environment is being entered. Several road humps/raised pedestrian crossings can then be used at appropriate spacings and at steadily increasing heights to keep the traffic speeds within desired limits as the traffic passes through the village. Once the halfway point (i.e. centre of the community) is reached and the highest road hump/raised pedestrian crossing has been passed, the road humps gradually reduce until the driver reaches the gateway or threshold at the other end of the village. This provides a very effective managed speed environment through the whole length of the village.

Roundabouts

Roundabouts are effective in reducing the severity of crashes at an intersection because they require traffic to deviate from a straight path and therefore slow down to undertake the manoeuvre.

The reduced speeds of travel through an intersection that a roundabout can achieve, together with the non right-angle nature of side-impact crashes because of the geometry of the roundabout, result in reduced crash severity.

Effective roundabout installation also relies on careful design of approach islands, clearly visible signs and markings, and effective public information campaigns about how they should be negotiated by drivers.

Catering for cyclist, pedestrian and motorcycle movements at roundabouts requires care, because drivers may fail to notice them as they concentrate on the 'give way' task inherent in travelling through a busy roundabout.

CASE STUDY: **Traffic calming in Rivas, Nicaragua**

The small town of Rivas on the Pan-American Highway was burdened by severe road crashes in the mid-1990s, many of which included vulnerable road users. In 1998, a traffic calming project was carried out with support from Danida to improve the situation. The project comprised pavements, road islands, bus bays and a roundabout.

The islands stagger the road and thereby force vehicle traffic to slow down before passing them. The islands also create a safe refuge for crossing pedestrians. Bus bays ensure that buses park off the road and passengers can get on and off safely. A speed-reducing roundabout in the most important junction in the town has slowed down vehicle traffic. The police, Policía Nacional, indicate that very few severe road crashes have occurred in the town since the traffic calming project was implemented, compared to the period before.

Damage-only crashes still occur and some truck drivers complain about the narrow road design. This was, however, to be expected because the narrow

design is the measure that lowers speeds and thereby increases safety. It has not been possible to retrieve old road crash data from before the project was implemented to draw conclusions about the exact impact on safety. Nevertheless, the road crash frequency is about one third of comparable road sections just outside the traffic calmed section and other towns on the Pan-American Highway through Nicaragua. It is a good example of the effect of a small reduction in speed in association with infrastructure treatments.



Pavement narrowings and engineering treatments at curves

Wider roads invite drivers to select higher travel speeds. This may be because the perceived margin for error is greater. So, narrower pavement widths tend to slow traffic speeds. Narrowing the roadway for motorized traffic will therefore assist speed reduction in an area.

CASE STUDY: **Narrowing treatment for a road in Sri Lanka**



Before treatment



After (simulated picture)

Courtesy of University of Moratuwa

Even narrowing the *perceived* lane width can achieve slower speeds. This can be done with painted markings in the road.

Specially designed road markings that create a stereoscopic illusion that the road is narrower than it is (and a resulting reduction in speed) have been trialled in number of districts in China on a variety of different types of road.



Curve warning signs are also effective in reducing crashes. Other treatments such as rumble strips across the lane of travel approaching the curve are also used in many countries.

An effective crash data system will enable higher risk curves and other hazardous locations to be readily identified.

3.4.2 Separation of vulnerable road users

Speed should be limited to ensure that vulnerable road users are not exposed to risk of serious injury (Box 3.11). If this is not possible, separating the vulnerable road users from motorized traffic is an alternative.

Pedestrian fencing is useful for improving the safety of pedestrians by directing larger flows of pedestrians away from random crossing locations (particularly in busy pedestrian crossing locations) to safer crossing points, which may be equipped with treatments such as speed humps or raised platforms in the roadway, or a set of traffic signals.

Refuge islands and medians can assist pedestrians in crossing the road by allowing a staged crossing and simplifying decision-making. Kerb extensions can also improve pedestrian safety by reducing the crossing distance, and the area and time in which the pedestrian is at risk. This is particularly helpful for older or disabled pedestrians who may have difficulty choosing a safe gap in traffic at a conventional crossing point.

In many situations in rural (and urban) areas there will not be any footpath provision for the large numbers of pedestrians walking from point to point. They will often be forced to walk on the carriageway. Provision of a walking path is a highly effective means of removing the pedestrians from a medium to high speed carriageway.

BOX 3.11: Vulnerable road user safety measures

Pedestrians have twice the risk of injury where they are not separated or segregated from motor vehicle traffic (24). The safety of pedestrians and cyclists can be improved through area-wide road safety management (25, 26).

Networks of segregated or separate pedestrian and bicycle routes connecting to a public transport system are ideal (27). Such a network might consist of sections of footpath or cycle path separate from roads, plus sections running alongside roads, with particular attention paid to safe crossings at junctions.

Traffic calming measures discourage motorized traffic from travelling at speeds that put pedestrians and cyclists at high risk. They include road narrowing, roundabouts, rumble strips and speed humps.

Widespread experience of area-wide road safety management in Europe shows that it can reduce crashes and injuries by 15–80% (28, 29). The town of Baden, Austria, launched a management plan in 1988 that has resulted in about 75% of its road

network being restricted to speeds of 30 km/h or less, and an integrated system of public transport with pedestrian and bicycle routes. The rate of road casualties has declined by 60% (30). Studies in Denmark (31) have shown that providing segregated bicycle tracks or lanes alongside urban roads reduced deaths among cyclists by 35%.

Low and middle-income countries have experimented little with area-wide road safety management, but some road safety experts believe that this should be a priority for urban areas in all countries (32).



Where paths are not in place and pedestrians walk on the road, educating pedestrians to walk as far off the road as possible and in the direction facing oncoming traffic is necessary.



Non-motorized two and three-wheeled vehicles carry vulnerable road users and tend to travel more slowly than motorized vehicles. Bicycles and tricycles or cyclos should be separated from motorized traffic as well, if at all possible.

3.5 Use of speed-limiting technology and intelligent speed adaptation

Collision speed and the shape and structure of vehicles involved in a crash affect personal injury or other types of damage. Lots of research goes into improving vehicle shells with safety in mind. Vehicle design is outside the scope of this manual, but there are technologies that can be adapted to the vehicles to improve drivers' speed compliance.

Road speed limiters (RSL)

This equipment is required by legislation on trucks and buses in a number of countries, including in Europe and Australia.

The European Community initially required limiters on trucks and buses over 12 tonnes and specified maximum speeds – 90 km/h for trucks and 100 km/h for buses. The requirement for these limiters has been extended to light commercial vehicles (over 3.5 tonnes) and small buses. In Australia, a 105 km/h maximum speed is permitted. RSL do not reduce speeding on roads with speed limits below the RSL settings, nor on steep downhill gradients.

Speed limiters are a measure that seeks to prevent the competitive nature of commercial freight (and bus) operations resulting in a lack of speed compliance on rural roads. Heavy vehicles (over 3.5 to 4.5 tonnes) are a higher risk to road users than other vehicles if involved in a crash.

It is recommended that speed limiters be introduced for heavy vehicles and possibly public service vehicles, in any country.



CASE STUDY: Speed limiters, Singapore

Vehicle engineering practices play an important role in Singapore in managing the speeds of vehicles on the roads. Heavy goods vehicles with maximum laden weight of more than 12 tonnes and buses of more than 10 tonnes must be fitted with approved speed limiters, with the set speed of 60 km/h. Light

goods vehicles with 3.5 tonnes and smaller buses with more than 15 passengers must not exceed 70 km/h on the road. A heavy fine of \$S1000 dollars (maximum) will be imposed for non-compliance. Illegal vehicle modifications are prohibited.

Electronic data recorders (EDR)

These devices record vehicle operating characteristics in the few seconds prior to, during and after a crash, such as speed, acceleration and airbag deployment. This data is highly useful for later detailed crash analysis and vehicle design refinements. In the

US where there is a high market penetration of EDRs (64% for 2005 model vehicles) NHTSA has indicated that their use results in fewer collisions because drivers drive more carefully (33).



CASE STUDY: **Application of dynamic event data recorders (SAGA system), Iceland**

Iceland is using a complete information system for monitoring and reporting:

- location and usage of vehicles
- speed compared with speed limits
- driving behaviour according to predefined criteria.

SAGA is used in the vehicle fleets of 70 companies. After data is processed and analyzed, results are downloaded onto an SQL-database. Reports on the data analysis are sent out to the owner by email. Iceland Post is one of the companies using the system. Since its introduction, significant improvements in driver behaviour have been noted, including less speeding and a reduction in accidents. The system

also leads to savings in operational costs of the fleet, especially in fuel consumption. Comparison of January-June 2005 statistics with those of the same period in 2004 shows the following results:

- 56% reduction in crash cost
- 43% reduction in the total number of crashes
- 51% reduction in the number of crashes where employees are responsible.

Some versions of the system can automatically send messages and fines when infringements are made (self-enforcement). However, acceptability issues for such a system are a major concern.

Source: (34)

Intelligent speed adaptation (ISA)

ISA refers to technology in a vehicle that enables it to 'know' the relevant speed limit from an on-board and updateable database of speed limits, and a Global Positioning Satellite (GPS) system advising where the vehicle is located. The system then provides feedback to the driver about whether current speed exceeds that limit.

There are three major types of ISA:

- informative – giving information to the driver
- voluntary supportive – driver can choose to set the maximum speed
- mandatory supportive – intervenes at all times when the vehicle exceeds the speed limit (but driver has an over-ride).

Transport companies are increasingly using GPS tracking systems to monitor their vehicle fleet, as well as driving speeds. Used in a vehicle, the device allows a driver to plot the best directions to a location, but it could also allow employers to track their movements. For example, a transport company operating in south-east Asia has in place a system of dedicated, security trained drivers, as well as container trucks equipped with GPS tracking. This provides peace of mind for customers transporting high-value goods such as electronic and computing components.

Some employers are now requiring vehicles to be fitted with speed alert and/or speed limiter devices to give drivers feedback, or to directly constrain the vehicles to pre-determined speed limits.

There are many issues surrounding reliability of speed limit data, the acceptability of mandatory supportive ISA and the substantial technical and policy decisions required of government before it can be required by regulation. However, informative ISA is likely to be supported by consumers and the infrastructure and new vehicle features needed for its introduction are under development.

It is now possible to install simple and cheap ISA systems in some types of private car which could provide a base for voluntary tracking of speed compliance.

Some insurance companies have pilot programmes with in-vehicle speed monitoring systems leading to reduced property and personal injury insurance premiums. These are reportedly showing promise (2). Discussions could be undertaken with insurance companies with a view to encouraging further pilot programmes in different countries.



3.6 Speed management by employers

Often fleet managers, public service drivers and truck drivers are under pressure to meet targets, resulting in speeding and driving for many hours – both negative for road safety. Fleet-owning organizations need to understand the risk of such behaviour and that introducing road safety and speed compliance measures will reduce long-term costs. Setting clear rules in regard to permissible maximum daily distances and number of driving hours, and observing speed limits are key elements.

There are substantial opportunities for corporate fleet managers to encourage employee compliance with speed limits in corporate vehicles. Moreover, they can assist their drivers to select safe speeds on their journeys with pro-active programmes. A number of multi-national companies have extensive journey management and other fleet safety programmes. In many countries the number of vehicles belonging to government, unions or private companies counts for a substantial part of the total fleet on the roads.

Employers are able to influence employees' use of company vehicles to an extent that cannot be achieved for drivers generally. Through monitoring the number and severity of breaches of speed limits leading to a traffic infringement or more serious charge, employers can have an effect upon the behaviour of drivers who are traditionally more likely to speed than others. Employers can build in a range of incentives or sanctions to encourage compliance, and an increasing number of companies are pursuing this approach. They can also use technology (such as speed limiters or tachographs) to reduce travel speeds.



CASE STUDY: Journey Risk Management

With private sector support, the Institute of Road Traffic Education (IRTE) has successfully completed the 'journey risk management' (JRM) of 12,000 km of national and state highways across India. The whole section of the road was categorized into different risk areas with a colour code. The final analysis is presented in two forms:

JRM booklet including:

- risk rate maps along with the type of risks and recommendations supported, with photographs of the hazards and the potential risk areas
- maps showing the different type of facilities, their location and distances

- emergency numbers for police stations, traffic aid centres, hospitals, medical facilities, service and repair shops, and other important services and facilities.

Emergency trump card showing:

- accident blackspots, and their risks
- recommended speed limit according to the type of risks
- time taken to travel the identified section of the road
- emergency phone numbers for the identified section of the road.

3.6.1 Legislative measures

Legislation introduced by governments for the freight industry can be a strong incentive for employers to address speed management with their employees. Governments can encourage employers to take an active role in driver/rider safety, including speed management, through occupational health and safety (OHS) legislation and through provisions in transport legislation. Increasingly, governments are specifying in legislation that OHS responsibilities extend to driving as a work task and to the vehicle as a *workplace*.

In New Zealand, for example, under the Health and Safety in Employment Act 1992 and the Health and Safety in Employment Amendment Act 2002, employers are responsible for the safety of their employees at work, which includes vehicles. This includes employees who are driving as part of their work – whether they are a driver, or a passenger, whether they drive regularly or occasionally, and whether the vehicle is owned, leased or rented by the company (Box 3.12).

BOX 3.12: ‘Chain of responsibility’ for commercial driving

In Australia, *chain of responsibility* principles are also being included in transport laws, attributing a share of responsibility for driver and vehicle compliance to all parties in the transport and logistics chain. These laws apply to all those organisations in the transport chain involved in the consigning, receiving or transporting of goods. For example, if there is an incident that involved a heavy vehicle driver exceeding safe speeds in order to meet a schedule, the transport company and even the goods consignor, may be found guilty of an offence if it was found that this influenced the driver’s decision to drive at an unsafe speed or falsify log book records.

Specific provisions of the legislative application of these national measures in the state of Queensland include:

“If the driver or other person in control of a heavy vehicle commits an extended liability offence, an influencing person is also taken to have committed the offence unless the influencing person proves [that they] exercised reasonable diligence and took reasonable steps to prevent the act or omission that is the offence.

An influencing person in relation to a vehicle means any or all of the following persons –

A person, other than the owner or registered operator, who controls or directly influences the loading or operation of the vehicle.”

Source: (35)

3.6.2 Education and feedback

Other ways that employers seek to monitor speeding and other unsafe road behaviours is through the installation of bumper stickers seeking public feedback. In this way, drivers know that if they drive at unsafe speeds or in other dangerous ways, someone may report this to their employer. In some cases, high-profile companies with vehicles featuring their name or logo will be contacted if their drivers seem to be travelling at excessive speeds or displaying other unsafe or uncourteous road behaviours.



As speeding is one of the major factors in work-related road crashes, employers can be assisted or advised to educate their employees about this risk. Governments and other agencies can help by producing basic education materials, such as those produced for the UK's Department for Transport by TRL for distributing to fleet companies (see www.dft.gov.uk/drivingforwork).

Summary

There is a range of speed management tools to assist in setting the speed environment, enforcing safe speeds, and informing drivers/riders about the speeds that are safe. It is important to consider how best to adapt these tools to the particular environment being addressed – physically, socially and politically – before using these tools.

- Identifying a hierarchy of roads that reflects road function – in both urban and rural areas – is a necessary first step, and an essential tool to manage speed in a consistent manner. Speed limits on roads at the same level in the hierarchy may vary, however, in response to major differences in risk along those roads, but consistency is desirable wherever possible.
- Appropriate speed limits are a fundamentally important tool for speed management. Speed limit guidelines need to be developed from a *Safe-system* approach. Factors such as road design, roadside (land use), traffic mix and flow, presence of vulnerable road users and vehicle quality factors will influence the limit. Clear speed limit signs need to be provided to inform drivers about applicable limits.
- Effective laws and regulations are essential. These must be supported by effective enforcement methods and practices, and an adequate range and depth of penalties for offenders.
- Public education is most likely to be an effective tool when it informs the community about the risks associated with speeding, promotes current enforcement activity and is reinforced by enforcement of speed limits.
- A range of low to medium-cost engineering treatment tools exists that provides proven safety benefits through addressing speed related risk in urban and rural settings.
- New vehicle technologies assist automatic compliance with speed. Their further development by the industry should be encouraged.
- Employers should not impose work schedules that require drivers to speed
- Employers should encourage speed compliance by employees who drive company vehicles. An increasing emphasis upon occupational health and safety by governments is placing obligations upon employers, particularly for vehicles engaged in freight movement.

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