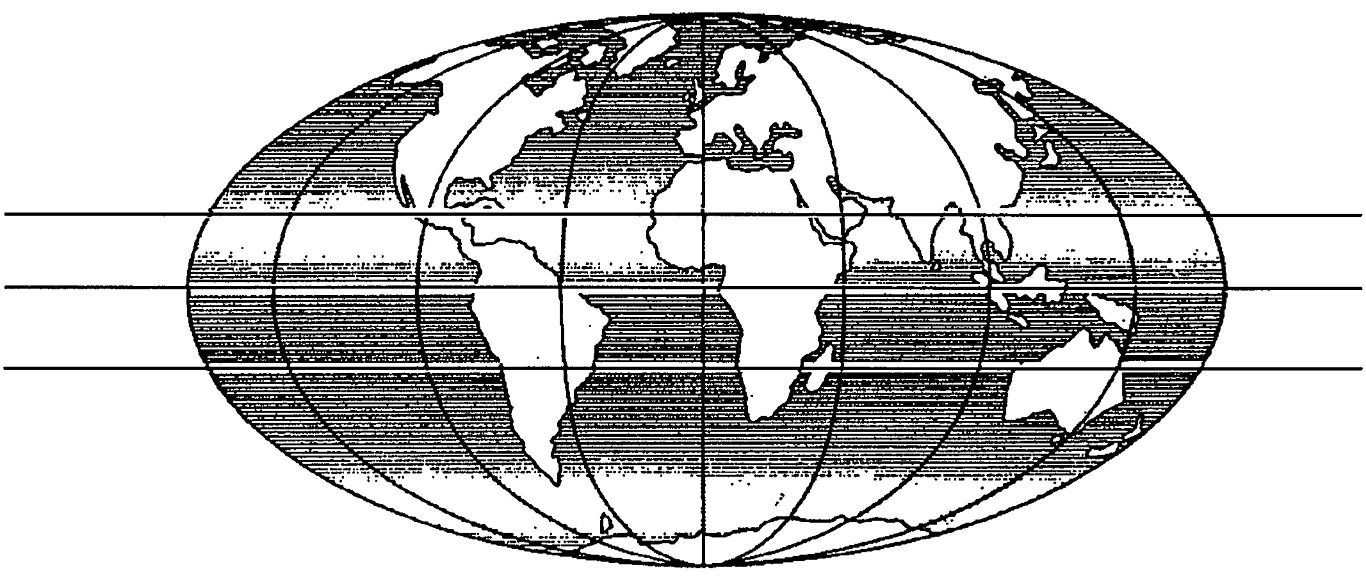
TITLE Low - cost engineering measures in Egypt, Ghana and Pakistan

by I A Sayer, C J Baguley and A J Downing



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LOW-COST ENGINEERING MEASURES IN EGYPT, GHANA AND PAKISTAN

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1. INTRODUCTION

The Overseas Unit of the Transport and Road Research Laboratory has been carrying out studies of road accidents in developing countries since 1972. Findings indicated that road accidents in Third World nations were a major cause of death and injury, and in selected countries accounted for almost 10 per cent of all deaths reported in the 5-44 year age group (Jacobs and Bardsley, 1981; Jacobs, 1986).

Other surveys showed that not only was the average fatality rate per licensed vehicle in Third World countries 10 times higher than that in developed countries, but that in a number of African and Asian nations, the road accident situation was worsening, whereas in Europe and North America accident rates were generally improving (Jacobs and Fouracre 1977, Jacobs,1986).

Research on accident costs (Fouracre and Jacobs 1976, Jacobs,1986) suggested that injury accidents were costing countries about one per cent of their gross national product (GNP) per annum. On this basis the total cost per annum for Third World Countries was found to be close to 25 billion $US (Downing, 1991) and this is clearly a sum that developing countries can ill afford to lose.

To improve road safety many developed countries have initiated integrated road safety programmes and implemented countermeasures that have been researched and developed to tackle their specific accident problems. The lessons learned from the developed countries' experiences should be of value to developing countries. However, differences in road-user behaviour and knowledge, and vehicle use and condition warn against directly transferring these safety measures to developing nations without additional research to verify their effectiveness. With this in mind, the Overseas Unit began joint studies to evaluate low-cost accident countermeasure schemes in a number of countries including Malaysia, Indonesia, Papua New Guinea (PNG), Egypt, Pakistan and Ghana. This paper describes the work being carried out in Egypt, Ghana and Pakistan.

Because the work is in progress, this paper cannot present conclusive results. Nevertheless in explaining the accident investigation approaches used and the surveys carried out for evaluation purposes it is hoped that it will assist and encourage other researchers to adopt similar trials of the accident reduction principles recommended in the Guide for Planners and Engineers (TRRL, 1991). The research conducted in Papua New Guinea is described in another paper being presented at the seminar (Hills B et al 1991).

2. REMEDIAL MEASURES: LOW-COST ENGINEERING IMPROVEMENTS

Road safety countermeasures can be conveniently classified into three types: engineering, education and enforcement. Although the importance of an integrated approach cannot be overemphasised, there is also clear evidence that many developed countries have achieved significant accident savings by investigating accidents systematically and introducing low-cost engineering improvements at hazardous locations. An example of the benefits that can be obtained is shown in Table 1, where an extremely high first year rate of return was achieved in a UK county highway authority. It should be noted that the accident reduction is probably overestimated in this case as no account has been taken of the regression-to-mean effect; however, the schemes are still likely to represent a substantial overall benefit.

In spite of the success of the schemes, developing countries have been relatively slow to adopt similar approaches and there has been little research to evaluate their effectiveness in the Third World.

In these countries the condition of roads and the vehicles, and the characteristics of the road-users' behaviour and knowledge can be markedly different from those in developed countries (Jacobs, Sayer and Downing 1981, Sayer and Downing 1981). Such differences suggest that some countermeasures which are effective in developed countries may not be as effective in Third World countries, implying there is a real need to carry out trials and evaluations of countermeasures.

Three countries which are among those at the forefront of such research are Egypt, Ghana and Pakistan. In each case, selected main towns or regions have improved their accident reporting and analysis systems by adopting TRRL's Microcomputer Accident Analysis Package (MAAP) which was specially developed for use in developing countries (Hills and Elliott, 1986).

TABLE 1.

Somerset County Council Summary of benefits of 13 low-cost schemes* carried out 1980-1983.

Total cost of 13 schemes	£5,500
Total injury accidents 3 years before	75
Total injury accidents 3 years after	12
Accidents saved in 3 years	63
Accident cost savings in 3 years	£422,000
Average 1st year rate of return**	2530%

* Signing, chevrons, reflector posts or double white lining.
** (Annual accident cost saving - cost of implementation) expressed as a percentage of implementation cost.

In introducing accident reduction schemes at hazardous locations each country attempted to follow the accident investigation approach recommended by the United Kingdom's Department of Transport (Department of Transport, 1986) which is now illustrated in the TRRL's Guide for Planners and Engineers (TRRL, 1991). The main stages were as follows:-

(1) collect objective accident data from police reports and store it on a microcomputer

(2) identify and rank the high accident sites

(3) identify the main accident types for each site by detailed analysis of the accident data

(4) make field visits to investigate the sites and collect survey data

(5) diagnose the accident problems and design appropriate low-cost remedial measure schemes

(6) implement the schemes on an agreed priority basis

(7) evaluate the schemes and amend the improvements as necessary.

These stages are described in more detail in the companion paper on PNG at this seminar (Hills et al, 1991).

3. EVALUATION STRATEGY

To encourage a common approach to evaluation the following basic strategy was adopted.

(1) Site selection

Usually sites are selected on the basis of their accident history, their suitability for improvement and sometimes because of political or public pressure. However, some research literature has highlighted the problem of the 'regression-to-mean' effect which leads to an overestimate of the treatment effects when only the worst sites are selected for improvement (Hauer, 1980). Ideally sites need to be selected at random from the list of hazardous locations but in practice this is rarely possible or acceptable to road authorities or engineers. Therefore when estimating the effects of treatment it is important that any 'regression-to-mean' effects are taken into account. Some guidance on the statistical methods is given by Wright et alia (1988).

(2) Control Groups

To isolate the effects of the treatment from other changes which may have occurred, it is necessary to collect data from control sites which ideally should be similar to the experimental ones which are being treated.

(3) 'Before and After' surveys

To estimate the effects of the treatment, a range of data needs to be collected from the experimental and the control sites before and after the dates when the improvements were implemented. Many of the surveys which can be carried out are useful for accident investigation as well as evaluation. The types of surveys needed will depend upon the accident problems and solutions required at each site. Some examples are outlined according to their necessity in Table 2.

(4) Other data required

It is important that some details are collected about the treatment at each site such as the date when the works started and finished and their costs. In addition, for cost-benefit analysis it is necessary to obtain estimates of time savings or delays and the costs of different types of accidents. A methodology for costing road accidents in developing countries is to be published by TRRL in 1991.

TABLE 2

Examples of evaluation/accident investigation surveys.

1.	Essential at all experimental and control sites. (a) detailed accident data (b) traffic volumes and composition including pedestrian flows if appropriate.
2.	Necessary for specific experimental sites with particular problems and solutions. The following are some examples of surveys which could be used if appropriate. (a) speed (b) frequency of vehicle manoeuvres (c) traffic violations (d) road-user delays (e) vehicle headways (f) sight distances (g) skidding resistance and texture depth (h) site geometry (i) physical features eg signs, markings, lighting, etc
3.	Useful if resources are available for an in-depth study. (a) conflicts (b) gap acceptance (c) road-users' behaviour, knowledge and attitudes

Currently the evaluation studies in Egypt, Ghana and Pakistan have reached the stage where the 'Before' studies have been completed and sites are being treated. The remainder of this paper describes some of the details of these studies in order to illustrate the systematic approach used and gives examples of the surveys being carried out and the remedial measures being introduced.

4. COOPERATIVE RESEARCH

4.1 Egypt

4.1.1 General accident investigation results

The Egyptian Academy of Scientific Research and Technology and the Overseas Unit began its programme of cooperative research in 1980 by designing a new police accident report booklet and developing a microcomputer programme (MAAP) for data analysis (Hills and Kassabgi, 1984). Ease of use was a key principle in the design of both the booklet and the software.

After establishing a road accident database for three areas of Cairo and the six main inter-city roads of Egypt, attention was focused on locating and treating hazardous road sites. Data for 1983-85 were used for the accident investigation and 'blackspots' were defined as those sites with five or more accidents per year for each of the three years in question.

The investigation approach outlined above was applied to the whole database but for this paper the Cairo-Alexandria Agricultural road has been taken as an example. This dual carriageway road is 240 kilometres long and is the busiest road in Egypt with an an Average Daily Traffic Flow (AADT) of 43,200 vehicles in 1984. It has a median of variable width, unsealed shoulders and is mostly straight and level with relatively few changes in either its horizontal or vertical profile.

During the three year period of study 1480 accidents were reported along the road. Compared with the other five intercity roads it had the highest fatal accident rate per kilometre per year (0.6) and the highest percentage of accidents which were fatal (28 per cent).

Having selected the road for study, the next step in the accident investigation process was the identification of the hazardous locations. A total of 18 sites were found to have had more than five accidents per year and the problems of these sites were investigated further by using the cross-tabulation and 'stick diagram' facilities of MAAP. This analysis indicated that half the sites were junctions and, although the distribution of accident types varied from site to site, it can be seen from Table 3 that pedestrian, nighttime and 'nose-to-tail' accidents featured fairly frequently.

After identifying the main accident types, preliminary visits were made to each site with checklists to identify the key physical characteristics at the site (see Appendix B of the TRRL Guide for Planners and Engineers, 1991). After the first visit a programme of surveys was drawn up as necessary. The investigation of the sites revealed that some of them were not suitable for low-cost treatment. Some of them were excluded because they were included in another road improvement scheme to add a third lane to each carriageway. The remaining sites were included in the evaluation study together with an equal number of similar control sites selected from the untreated section of the road. Kilometre 60 was typical of the experimental sites and the survey results and the remedial measures proposed for this site are described in detail below.

4.1.2 Surveys and remedial measures at km 60

Kilometre 60 was a 'T' junction close to a railway crossing where drivers travelling from Cairo had to make an awkward left turn (see Figure 1) before they could enter the road leading to a large village on the eastern side of the main road.

TABLE 3.

Hazardous locations on the Agricultural road, 1983-85.

Kilometre	Number of accidents		Main accident type ( ) = %	Junction (J) or link (L) accident
	Fatal	Non fatal		
9	12	33	Pedestrian (64)	L
10	8	26	Pedestrian (35)	L
11	5	18	Nighttime (39)	L
12	8	17	Nighttime (36)	J
15	9	15	Nighttime (42)	L
20	12	7	Pedestrian (37)	J
26	2	17	Pedestrian (42)	J
30	3	15	Nighttime (39)	L
35	8	28	Nighttime (42)	L
38	2	25	Nighttime (33)	L
40	6	14	Nighttime (70)	L
45	5	19	Nose-to-tail (33)	J
60	5	14	Left turn (26)	J
65	9	17	Pedestrian (31)	J
70	2	17	Nose-to-tail (26)	J
75	4	12	Nighttime (31)	J
79	6	11	Nose-to-tail (29)	J
80	8	19	Nighttime (30)	L

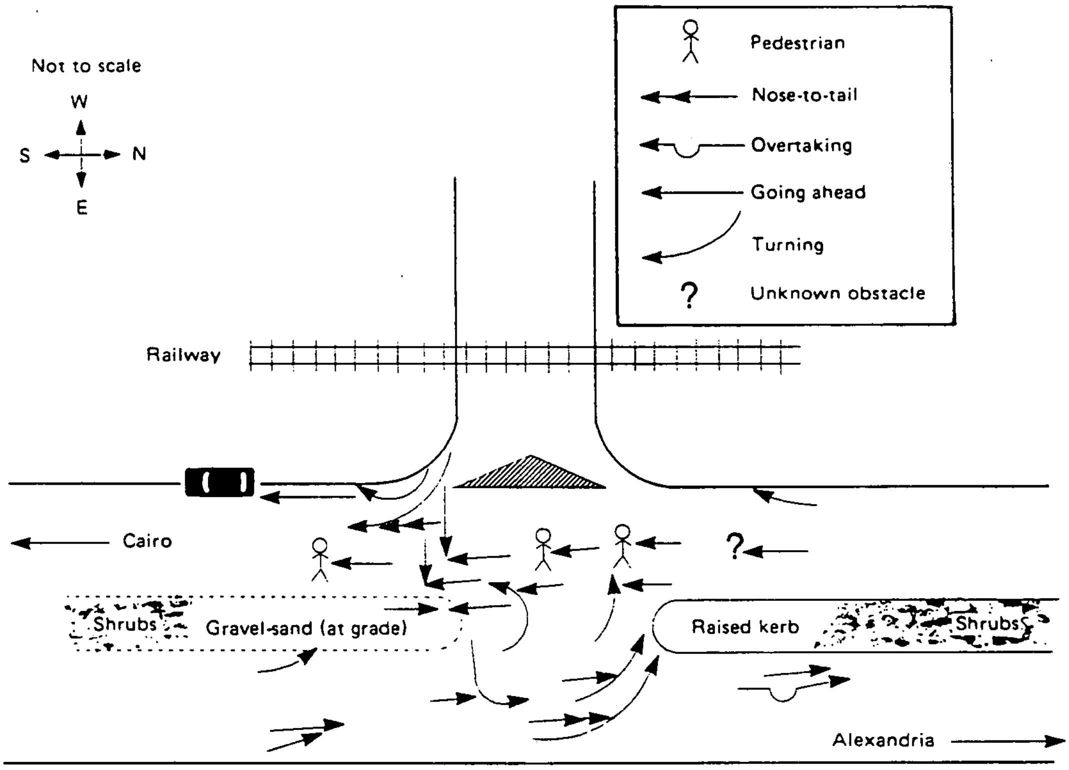


Fig.1 Collision diagram for junction at kilometre 60

During 1983-85, 19 accidents were reported at kilometre 60 (see Figure 1). Five of these accidents (26 per cent) were fatal, and 13 (68 per cent) involved personal injury. Twenty one per cent of the accidents were at night and 16 per cent involved pedestrians, none of which were fatal. The majority (52 per cent), of accidents involved turning or crossing vehicles and from Figure 1 it can be seen that on the Alexandria carriageway at least half the accidents involved a vehicle making a left turn.

Some of the features revealed by the site visit were as follows:-

(1) no left turn lane for drivers on the Alexandria carriageway

(2) poor junction layout on the minor road

(3) stop signs on the minor road but no warning signs on the major road

(4) lamp-posts found on both major and minor road but only those by the railway crossing were working

(5) trees and hoardings at the site that could reduce sight distances.

As well as collecting information on accidents and traffic flows and movements, a range of surveys was carried out to investigate specific problems in-depth. Some examples of these and some of the results are shown in Table 4. From the surveys it was clear that nearly a third of the drivers were disobeying the stop sign. Although fewer drivers were speeding or following too closely, both factors could have contributed to the turning and 'nose-to-tail' accidents.

TABLE 4.

Summary of selected survey results at km 60.

Possible accident factor	Survey	Main survey result
Vehicles not stopping or crossing incorrectly at junctions	Road-user behaviour observations	Minor road vehicles not stopping at main road: Daytime = 31% Nighttime = 32%
Nose-to-tail accidents Following distances too short Poor knowledge of stopping distances	Vehicle gap size measurements Driver interviews	About 15% of vehicles had gaps less than two seconds long 79% of drivers under-estimated distance needed to stop safely at speed of 60km/h
Excessive speed	Speed measurement	5% of traffic exceeded the speed limit of 90 km/h
Nighttime accidents. Vehicles travelling with inadequate lighting	Vehicle lighting observations	Headlights: 10% inadequate light 6% not using lights Rearlights: 12% with inadequate lighting

Of the above items, (1) to (4) have been implemented and monitoring is continuing at the site.

As a result of the investigations the following recommendations were made to improve the site.

(1) provide a protected turning lane on the Alexandria carriageway

(2) provide signing on the main road to warn of the junction ahead

(3) remove obstructions at the junction which interfere with visibility

(4) redesign the minor road junction

(5) improve the street lighting.

4.2 Pakistan

In December 1988, The Karachi Development Authority's Traffic Engineering Bureau (TEB) and the TRRL agreed to start a joint study into the effectiveness of improved pedestrian crossing facilities as part of TEB's Immediate Action Plan to improve road safety in the city.

Karachi, the largest city in Pakistan, has a population of six million people which generates 45 per cent of all the motor traffic in Pakistan. One of its most disconcerting statistics is the number of people killed and injured on its roads; the pedestrian accident problem being particularly serious. For example, in 1987, 54 per cent of the 588 people who died on the roads were pedestrians. Seventy three per cent of all pedestrian casualties were injured whilst crossing the road and 85 per cent of the fatalities occurred away from junctions.

The TEB installed a version of TRRL's MAAP in 1986 and as part of the Immediate Action Plan the Bureau produced a list of hazardous locations which required improving. Because of the serious pedestrian accident problem provision of safer crossing places was given a high priority. At-grade pedestrian crossings (zebras) are plentiful in Karachi but surveys of driver behaviour (Downing, 1991) indicated that virtually no drivers stopped for pedestrians waiting at the crossings. Consequently few pedestrians used them. Also a few signal-controlled crossings have been introduced in Pakistan but they tend to have a tarnished reputation in developing countries due to their unreliable operation and poor observance of the red signal by drivers. With these points in mind, the TRRL and the TEB planned an alternative form of crossing with the overall aim of reducing traffic speeds and encouraging drivers to give way to pedestrians using crossings. Reducing speeds was considered important as there is a large amount of evidence (eg. Baguley, 1981; Stephens, 1986; Fieldwick & Brown, 1987) indicating that low vehicle speeds reduce both the number and severity of accidents.

This study is therefore somewhat different from the one in Egypt in that it aims to evaluate a 'mass action' programme in which only one or two measures are to be introduced at a range of sites with similar problems.

4.2.1 Remedial measures proposed

The use of road humps (known locally as speed breakers) to reduce vehicle speeds has become commonplace in Karachi but only a few of these conform to UK standards, and all manner of hump sizes exist throughout the city. Nevertheless, they do appear to be generally effective in reducing speed and incorporating this type of self-enforcing device with a raised pedestrian crossing facility seemed an appropriate remedial measure for the link pedestrian accidents which occurred away from junctions in Karachi.

To promote consistent driver behaviour and awareness, a standard layout was considered essential to ensure that drivers received the same advance warning cues for this new type of crossing. The layout proposed is shown in Figure 2. The driver is first presented with a triangular warning sign of the graded humps and crossing, and then encounters a very low hump (40cm maximum height) that is designed to produce little or no speed reduction but serves simply as an alerting device. The next hump of 65cm height should produce crossing speeds of around 30km/h. The zebra crossing is marked on the final, flat topped, standard 3m wide, 100cm high speed breaker (5m overall length). Road humps of the same height and 3.7m length (UK standard) have been found to produce consistent mean crossing speeds of 18km/h (Sumner & Baguley, 1979; Baguley, 1981).

It is hoped that the raised zebra crossing will have the following advantages:

(1) greater usage. For pedestrians the step down from the kerb is removed or reduced, encouraging them to cross at what should now be the slowest point on the road for passing traffic.

(2) increased safety. All vehicles should slow down to a similar level to avoid occupant discomfort, and thus owing to the much narrower band of vehicle approach speeds, pedestrians should make fewer errors of judgement of safe gaps in the traffic stream. Any collisions that do occur are likely to be less severe than those that occur at the existing higher speeds.

(3) pedestrian priority. As drivers should be decelerating to very low speeds to cross the raised zebra, it is hoped that they will be more willing to give way to pedestrians using the crossing.

(4) greater pedestrian conspicuity. Pedestrians on a raised crossing should be more visible to drivers. Hopefully, drivers will now be focusing more of their attention in the vicinity of the crossing and pedestrians should be less likely to go unnoticed.

An obvious disbenefit associated with these crossings is that drivers have to slow down whether or not pedestrians are crossing the road.

Uncontrolled crossings are not usually suitable for sites with very heavy continuous pedestrian crossing flows because they can cause serious disruptions to the motor traffic. In these cases at-grade crossings need to be light controlled and two Pelican crossing sites were also included in the study. More details on countermeasures for pedestrian accidents are given in the TRRL Guide for Planners and Engineers (TRRL, 1991).

4.2.2 Site selection and evaluation

Seven sites were selected for the above type of treatment and two for pelican crossings from the Immediate Action Plan. The choice was based on their suitability, often where at-grade crossings already existed, rather than at the worst accident blackspots in Karachi.

In addition, three sites where no changes were planned were selected as 'controls' so that any changes in factors such as travel pattern, traffic levels etc could be taken into account.

The accident data were analysed for each of the sites (see Table 5) and this was followed by a preliminary site visit where basic information was collected on check sheets and all of the sites were photographed. Thereafter a systematic programme of surveys was drawn up. One-day surveys were carried out at each site and a rigorous schedule was followed. It was made up of five, one-hour observation periods which matched the vehicle and pedestrian peak and off-peak hours between 0830 and 1600 hours. No surveys were carried out on Fridays (Islamic rest day). Surveys included classified vehicle counts, vehicle journey times through the section to be treated, the speed of vehicles approaching the pedestrian crossing location, driver stopping behaviour, and pedestrian flows, crossing times and their delays whilst waiting to cross. In the 'Before' situation the mean approach speeds were found to be high; ranging from 35 to 55km/h. With the exceptionally high flows, particularly at sites 1 to 4, and relatively large carriageway widths (see Table 5), crossing the road on foot was often a difficult and hazardous task.

TABLE 5.

Sites to be treated in Karachi.

Site	Type	Est'ed AADT	Road width(m)	Accidents per year	Counter-measure
1.MA Jinna Rd	Urban T	168700	14.3	1.3	Pelican
2.University Rd,Urdu	Urban T	110200	9.3	6.0	Pelican
3.Manghopir Rd	Urban D	85600	9.8	1.7	Raised zebra
4.Hakim Ibne Sinna Rd	Urban D	69700	13.1	3.0	Raised zebra
5.Korangi Rd Quay.bus	Subur'n S	31100	14.5	14.0	Raised zebra
6.Bunder Rd, nr. P.O.	Urban S	37000	20.2	3.7	Raised zebra
7.Bunder Rd, KPT gate	Urban D	37000	11.7	2.7	Raised zebra
8.Korangi Rd, 3.5 bus	Subur'n D	22700	7.0	4.0	Raised zebra
9.Korangi Rd, 5.5 bus	Subur'n D	13100	10.0	1.7	Raised zebra

Notes: bus=bus stop. S=single, D=double, T=triple carriageway.
Road width=shortest distance between kerbs (ie. due to median, widths for dual carriageway are for one direction only.
Accidents are believed to be considerably under-reported in Karachi.

The pedestrian counts were made in the vicinity of the proposed new crossing and also in areas 50m on each side, in order to determine whether more pedestrians were attracted to the crossing. The other pedestrian measurements were intended to monitor whether the situation was improved for pedestrians by reducing both their delay at the kerbside and their exposure to risk whilst crossing the road. Vehicle journey times over the 200-300m section that included the new installation were monitored to assess the approximate economic disbenefit of any increase in journey time associated with the remedial measure.

Data were obtained using trained field staff backed up by video recordings. Teams of observers collected the data using chiefly stopwatches and button counters. Journey time measurements were obtained by reading (into hand-held dictaphones) part of the registration plates of various vehicle types (sampled where necessary) against synchronised stopwatch times. These data were subsequently transcribed and analysed by computer.

Most of the measures have now been installed and it is planned to carry out the 'After' surveys later this year when cost information will also be obtained.

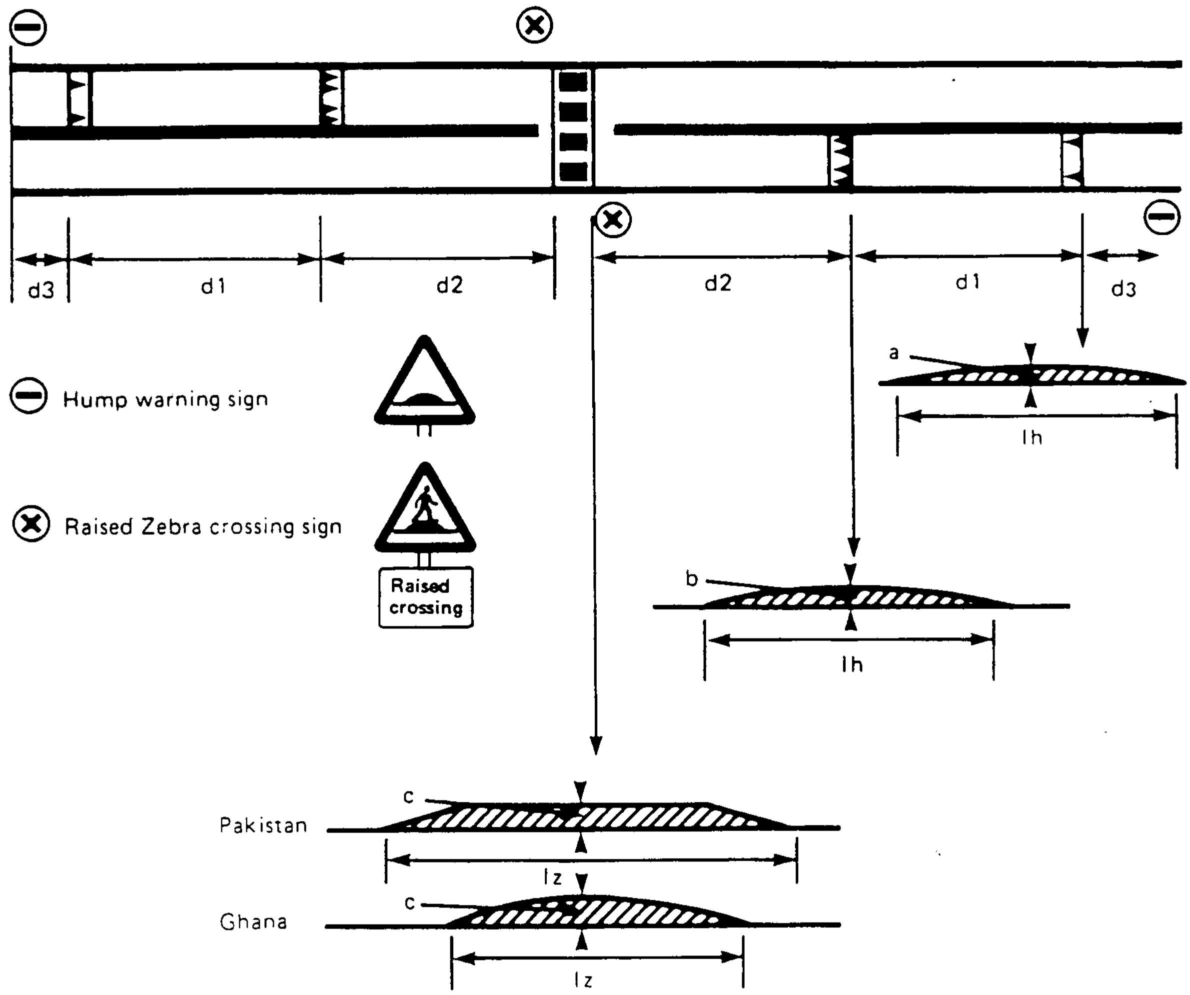
4.3 Ghana

The most recent (1984) road accident data available for Ghana showed that the fatality rate of 112 deaths per 10000 vehicles made it the fifth highest in the world (ie. 35 to 40 times higher than rates in the more industrialised countries). Because of the serious accident problem, a demonstration road safety project was included in a World Bank funded, three-year Transport Rehabilitation Project and it is currently being implemented by a British consultant (Ross-Silcock Partnership), with the Buildings and Road Research Institute (BRRI), Ghana.

The Project started in late 1988 with the introduction of TRRL's MAAP. Police records for 1987 to 1988 from the Ashanti region were backcoded and entered into the MAAP system. With this data the BRRI were then able to diagnose the accident problems and identify hazardous locations. Ten sites were selected for improvement and the BRRI and TRRL agreed to evaluate the countermeasure programme.

As in Karachi, the pedestrian problem was again identified to be very serious with half of all the fatalities being pedestrians. The characteristics of the pedestrian casualties were also similar in that 66 per cent occurred away from junctions and 62 per cent were killed or injured when crossing the road.

In Ghana the data also included some accident information on village rural roads and there was some evidence of dangerous bends. The remedial measure programme was therefore targeted at these two accident problems and consequently the study approach was similar to the one in Karachi, that is it was restricted to monitoring only two measures rather than a range of improvements as in Egypt.



	For Pakistan:–	For Ghana:–
a =	40mm	40mm
b =	65mm	40mm
c =	100mm	65mm
1h =	3.7m	3.7m
1z =	5m	3.7m
d1 =	50m	50m urban 100m rural
d2 =	50m	75m urban 100m rural
d3 =	12m	Variable

Fig.2 Proposed layouts for raised Zebra crossings in Pakistan and Ghana

4.3.1 Remedial measures proposed

It was agreed with the Ghanaian Highway Authorities that raised pedestrian crossings would be tried at seven sites. However there was some concern about the possibility of drivers encountering the humps at high speeds owing to the generally low flows, particularly on the rural roads, and also that the humps would produce unacceptable delays to drivers. The authorities therefore adopted lower humps and slightly different types of layout to those to be used in Karachi, as shown in Figure 2. The differences included the use of standard road humps for the crossings, i.e. segment of a circle in cross-section rather than trapezoidal. Also, alternative spacings and additional warnings in the form of rumble areas were planned for some rural village sites where approach speeds were high.

At bends it was agreed to introduce or reinstate edge-line and centre-line markings, triangular bend warning signs and chevron boards. Several examples of these types of measure are given in the Guide for Planners and Engineers (TRRL, 1991).

4.3.2 Site selection and evaluation

To select the sites, lists of the worst locations (see Figure 3) were produced using MAAP. The data for these sites were then analysed in detail and preliminary site visits made. From the information collected, seven sites were selected for raised pedestrian crossings and three were selected for bend improvements (see Table 6).

LISTING THE WORST ACCIDENT SITES

		Improvement site (no. in Table 5	
Link 0036/0037	21 accidents	-	4
Link 0174/0175	21 accidents	-	1
Link 0035/0036	16 accidents	-	2
Link 0146/0165	15 accidents		
Link 0173/0174	14 accidents		
Link 0161/0167	14 accidents		
Link 0159/0179	11 accidents		
Link 0145/0146	11 accidents		
Link 0208/0209	11 accidents	-	3
Link 0166/0167	11 accidents		
Link 0154/0650	10 accidents		
Link 0161/0165	10 accidents		
Link 0430/0549	10 accidents		
Link 0165/0166	10 accidents		
Link 0573/0574	10 accidents		

Fig.3 MAAP listing of the worst road sections in Kumasi (1987 and 1988 data).

From Table 6 and Figure 3 it can be seen that three of the pedestrian sites had the highest numbers of accidents in the project area. The other experimental sites were not necessarily those with the worst records but they were chosen because they were most appropriate for the countermeasures being considered. Also out of the large list of hazardous locations, five 'control' sites were identified and they were chosen on the basis of their similarity with the experimental sites.

TABLE 6.

Sites to be treated in Ghana.

Site (Kumasi & environs)	Type	Est'ed AADT	Road width(m)	Accidents per year	Counter-measure
1. Bantama Road	Urban D	13090	6.7	11.0	Raised zebra
2. Kwadaso	Subur'n S	8815	7.4	8.0	Raised zebra
3. Aboabo Highway	Urban D	8260	7.3	16.5	Raised zebra
4. Asuoyeboa	Subur'n S	6650	7.5	10.5	Raised zebra
5. Tanosa	Rural S	4220	7.4	5.0	Raised zebra
6. Odumasi	Rural S	2840	7.4	6.0	Raised zebra
7. Ejisu	Rural S	3910	7.1	5.5	Raised zebra
8 Sepwusuansa	Subur'n S	4000	7.0	3.0	Signs/Lines
9. Accra Rd km214	Rural S	2610	7.2	4.0	Signs/Lines
10. Accra Rd km211	Rural S	2610	10.8	3.5	Signs/Lines

Notes: S=single, D=double carriageway. Road width=shortest distance between kerbs (ie. due to median, widths for dual carriageway are for one direction only).

The same type of roadside surveys carried out in Pakistan were replicated at the above raised crossing sites. At the bend sites, traffic flows and entry speeds were monitored. At all the sites excessive speed was suspected to be a key factor and speed monitoring was therefore seen as very important.

Once the countermeasures are installed the surveys will be repeated and in addition, information will be collected on the costs of the works, the costs of accidents and on the value of time.

5. SUMMARY

(1) Previous research by the Overseas Unit of TRRL has shown that despite lower levels of motorisation, road accident rates in developing countries are generally much higher than those in the more industrialised nations. Research is now

being concentrated into low-cost engineering countermeasures because of their considerable potential and because few developing countries have implemented such schemes.

(2) The paper has described low-cost schemes which are being implemented in Egypt, Pakistan and Ghana and are currently being evaluated with the help of the Overseas Unit of TRRL. In describing these projects the paper has emphasised the need for:-

(a) a good road accident database both for planning road safety improvements and for research

(b) a systematic approach for carrying out road safety improvement schemes; and

(c) a scientific evaluation of the effectiveness of the improvements using 'Before and After' studies at both improved sites and at control sites which have remained unaltered.

(3) Also, the paper has outlined some alternative designs for pedestrian crossings and the types of surveys that are being carried out in order to evaluate the benefits and disbenefits of these designs with a view to drafting appropriate standards.

(4) Because these studies are relatively new it is impossible to comment on the effectiveness of the schemes or designs at this stage. However, it is hoped that this paper will encourage other countries to adopt similar schemes on a trial basis and to evaluate their effectiveness.

6. ACKNOWLEDGEMENTS

The authors would like to express their gratitude to the Egyptian Road Safety Committee; the Traffic Engineering Bureau of the Karachi Development Authority, Pakistan; the Ministry of Transport and Communications and the Buildings and Road Research Institute, Ghana who have so readily cooperated in this research and made available various facilities and manpower. The authors would also like to acknowledge the assistance of UK consultants, Ross-Silcock Partnership who are currently carrying out the demonstration project in Ghana. The work described in this paper forms part of the programme of the Transport and Road Research Laboratory and the paper is published by permission of the Director.

7. REFERENCES

BAGULEY, C J, 1981. Speed control humps - further public road trials, TRRL Laboratory Report 1017. Crowthorne: Transport and Road Research Laboratory.

DOWNING, A J, 1991. Pedestrian Safety in Developing Countries. Proceedings of The Vulnerable Road User, International Conference on Traffic Safety. New Delhi: Macmillan India Ltd.

DOWNING, A J, 1991. Road Safety in Developing Countries. Safety 91 - Proceedings and Programme. Crowthorne: Transport and Road Research Laboratory.

FIELDWICK, R and R J BROWN, 1987. The effect of speed limits on road accidents. Traffic Engng. & Control. (December 1987), 635-640.

FOURACRE, P R and G D JACOBS, 1976. Comparative accident costs in developing countries. TRRL Supplementary Report 207. Crowthorne: Transport and Road Research Laboratory.

HAUER, E 1980. Bias by selection: Overestimation of the effectiveness of safety countermeasures caused by the process of selection for treatment. Acc. Anal. Prev., (12), 113-117.

HILLS, B L, and M KASSABGI, 1984. A Microcomputer Accident Analysis Package and its use for developing countries. PTRC Summer Annual Meeting, University of Sussex, 10-13 July 1984, Proc of Seminar F. London: PTRC Education and Research Services, 97-120.

HILLS, B L, and G J ELLIOTT, 1986. A Microcomputer Accident Analysis Package and its use for developing countries. Srinigar:
Indian Roads Congress, Road Safety Seminar.

HILLS, B L, N M THOMPSON, and K KILA, 1991. Accident reduction research in Papua New Guinea. PTRC Summer Annual Meeting, University of Sussex. 9-13 September 1991, London: Proc of Session C, Towards Safer Roads in Developing Counties. PTRC Education and Research Services.

JACOBS, G D, 1986. Road accident prevention: the work of the Overseas Unit, TRRL. IN: Department of Transport et al. Sino-British Highways and Urban Traffic Conference. UK papers presented in Beijing, 17-22. November 1986.

JACOBS, G D and M BARDSLEY, 1981. Road accidents as a cause of death in developing countries. TRRL Supplementary Report 646. Crowthorne: Transport and Road Research Laboratory.

JACOBS, G D and P R FOURACRE, 1977. Further research on road accident rates in developing countries. TRRL Supplementary Report 270. Crowthorne: Transport and Road Research Laboratory.

JACOBS, G D, I A SAYER and A DOWNING, 1981. A preliminary study of road-user behaviour in developing countries. TRRL Supplementary Report 646. Crowthorne: Transport and Road Research Laboratory.

SAYER, I A and A J DOWNING, 1981. Driver knowledge of road safety factors in three developing countries. TRRL Supplementary Report 713. Crowthorne: Transport and Road Research Laboratory.

SAYER, I A and R HITCHCOCK, 1984. An analysis of police and medical road accident data: Sri Lanka 1977-81. TRRL Supplementary Report 834. Crowthorne: Transport and Road Research Laboratory.

STEPHENS, B R, 1986. Road humps for the control of vehicular speeds and traffic flow. Public Roads. 50(3), (December 1986), 82-90.

SUMNER, R and C J BAGULEY, 1979. Speed control humps on residential roads. TRRL Laboratory Report 878. Crowthorne: Transport and Road Research Laboratory.

TRANSPORT AND ROAD RESEARCH LABORATORY, 1991. Towards safer roads in developing countries. A guide for planners and engineers. Crowthorne: Transport and Road Research Laboratory.

TRANSPORT AND ROAD RESEARCH LABORATORY (1991 - TO BE PUBLISHED). Costing road accidents in developing countries. TRRL Overseas Road Note 10. Crowthorne: Transport and Road Research Laboratory.

WRIGHT, CC et al, 1988. Estimating the regression-to-mean effect associated with road accident blackspot treatment: towards a more realistic approach. Acc. Anal. Prev, 20(3), 199-214.