

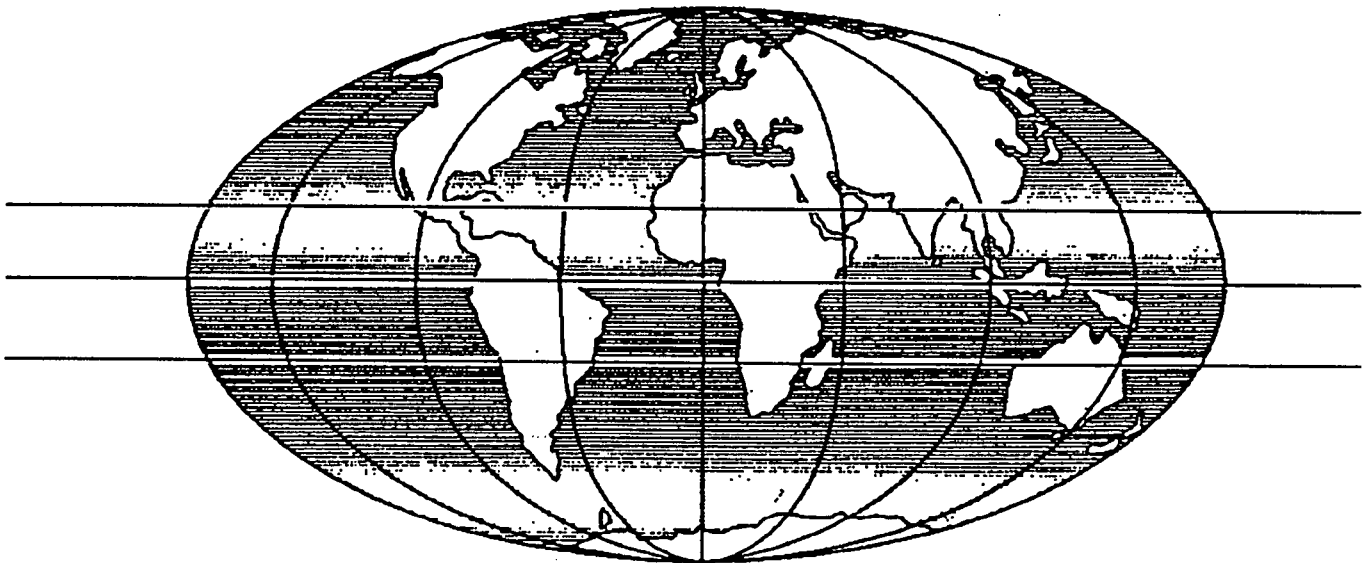


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# Reprint

**TITLE** Current research into the effectiveness of some low-cost engineering remedial measures in developing countries

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# CURRENT RESEARCH INTO THE EFFECTIVENESS OF SOME LOW-COST ENGINEERING REMEDIAL MEASURES IN DEVELOPING COUNTRIES

by

I A Sayer and C J Baguley

## *Abstract*

*Increasingly, developing countries are becoming aware of their serious road accident problem and a growing number of authorities in these countries are introducing programmes aimed at reducing accidents in both frequency and severity.*

*In cooperation with the respective authorities in the countries of Egypt, Pakistan and Ghana, the Overseas Unit of the Transport and Road Research Laboratory, United Kingdom, has been researching the use of low-cost engineering remedial measures in developing countries. The work has just reached the implementation stage and discussions of the effectiveness of the measures introduced will be published later in reports and papers. This paper describes the research programme, the remedial measures being introduced and the roadside evaluation studies carried out.*

*Low-cost engineering improvements schemes have proved to be very effective in developed countries. However, because of differences in behaviour, attitudes and knowledge of road-users and in vehicle use and condition, their benefits in Third World countries are less certain. Consequently, the current research programme has concentrated on evaluating the introduction of self enforcing measures at hazardous locations in developing nations. For instance in Egypt, the work has centred on improving dangerous sites on an important inter-city road, where problems included 'nose-to-tail', pedestrian, nighttime and tyre burst accidents. In Pakistan and Ghana improving urban and rural pedestrian crossing facilities was identified as the main requirement.*

## 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 (Jacobs and Bardsley 1981; Jacobs, 1986).

Other results showed that not only was the average fatality rate (fatalities per 10,000 licensed vehicles) from Third World countries 10 times higher than that from 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. A sum that developing countries in particular cannot afford to lose on a regular basis.

Most developed countries have initiated integrated road safety programmes and

implemented countermeasures that have been researched and developed to suit the accident characteristics of individual countries. The lessons learned from the developed countries' experiences should be of value to developing countries. However, differences in road-user behaviour, knowledge, 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 a programme of cooperative research into the use of low-cost road safety remedial measures in Egypt, Pakistan and Ghana. Because the work is currently in progress, this paper cannot present conclusive results, but describes the surveys carried out and the physical measures being implemented.

## 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.

TABLE 1.

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

Total cost of 13 schemes	£5,497
Total injury accidents 3 years before	75
Total injury accidents 3 years after	12
Accidents saved in 3 years	63
Accident savings in 3 years	£422,100
Average 1st years rate of return**	2500 %

\* Signing, chevrons, reflector posts or double white lining.

\*\* (Annual accident cost saving - cost of implementation) expressed as a per centage of implementation cost.

Unlike most developed countries, relatively few developing countries have instituted systematic accident reporting, recording, analysis and remedial measure programmes, and consequently there is a great lack of knowledge of the effectiveness of particular road safety improvement schemes in the Third World. In these countries the roads, vehicles and their uses, and the road-user behaviour, knowledge and respect for enforcement (Jacobs, Sayer and Downing 1981, Sayer and Downing 1981), can be markedly different to that found in developed countries. Such differences suggest that some countermeasures which are effective in developed countries may not be as effective in Third world countries. Thus

there is a real need to carry out trials and evaluations in the field, and for the past few years the Overseas Unit has been encouraging and cooperating with developing countries in such programmes of research.

Three countries that have been particularly helpful in providing these research opportunities were Egypt, Ghana and Pakistan. Their main strengths were that they were keen to tackle the road safety problem and had recently introduced systematic data collection and analysis systems. The accident analysis software package (MAAP) was specially developed by TRRL for use in developing countries (Hills and Elliott 1986).

In each country, the general approach to accident investigation was to:-

- 1) collect objective accident data from police reports and store it on a micro computer;
- 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, 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; and
- 7) evaluate the schemes and amend the improvements as necessary.

In effect, the approach was similar to that as recommended by the United Kingdom's Department of Transport, (Department of Transport 1986) for use in its local highway authorities.

As stated above, in each of the three countries, the research programme is at the point where stages (1) to (5) have generally been completed and stage (6) and (7), that is, implementation and monitoring, are currently under way.

### 3. Cooperative Research

#### 3.1 Egypt

The Egyptian government and the Overseas Unit began its programme of cooperative research in 1980 by developing a model accident report booklet for use by the traffic police in Third World countries and also by developing the Microcomputer Accident Analysis Package (MAAP), (Hills and Elliott 1986).

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 in the areas selected. 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. The road is 240 kilometres long and consisted of four traffic lanes (two in each direction), a median of variable width, and unsealed shoulders. In general the geometry was straight with relatively few changes in either its horizontal or vertical profile. It is the busiest road in Egypt and in 1984 had

an Average Daily Traffic Flow (AADT) of 43,200 vehicles.

Of the 1480 accidents on the Agricultural road during 1983-85, 28 and 65 per cent were fatal and injury accidents respectively, giving the road the highest casualty record of the six inter city roads studied.

For the low-cost remedial measure research programme on the Agricultural Road, the section kilometre 9 to 85 was studied in detail. The first step was to identify the high accident sites, and Table 2 lists the 18 blackspots found in the study section.

Using the 'Stick Diagram Analysis' facility of the MAAP, each site's accident patterns were identified. The main types of accident occurring at the 18 sites were: pedestrians, nighttime, nose-to-tail and tyre bursts.

TABLE 2.

High accident sites on the Agricultural road, 1983-85.

Kilometre	Number of accidents	
	Fatal	Other
9	12	33
10	8	26
11	5	18
12	8	17
15	9	15
20	12	7
26	2	17
30	3	15
35	8	28
38	2	25
40	6	14
45	5	19
60	5	14
65	9	17
70	2	17
75	4	12
79	6	11
80	8	19

To investigate the factors involved in these accidents, visits were made to the sites, inventories made, and roadside surveys and interviews were carried out by trained observers. For example, the high incidence of tyre bursts was investigated by surveying tyre condition and, not surprisingly, it was found that in general tyres were not satisfactory: sixteen per cent of light vehicles had one or more tyres with less than 1mm depth of tyre tread and the same percentage of vehicles had a difference of at least 20 psi between the tyres with the lowest and highest pressure.

From Table 3 it can be seen that some of the main factors contributing to the accident patterns were poor driver behaviour at junctions, poor knowledge of road signs, inadequate vehicle lighting, inadequate following distances, poor knowledge about stopping distances, and poor pedestrian knowledge.

TABLE 3.

Summary of selected survey results at hazardous locations.

Possible accident factor	Survey	Main survey result
Excessive speed	Speed measurement	5% of traffic exceeded the speed limit of 90 km/h.
Vehicles not stopping or crossing incorrectly at junctions.	Road-user behaviour observations	Minor road vehicles not stopping at main road: Daytime = 31% Nighttime 32%
Road signs not understood.	Driver interviews	18% of drivers were unable to identify 10 test signs correctly.
Nighttime accidents. Vehicles travelling with inadequate lighting.	Vehicle lighting observations	Headlights: 10% inadequate light 6% not using lights Rearlights: 12% with inadequate lighting.
Nose-to-tail accidents. Following distances too short.	Vehicle gap size measurements	About 15% of vehicles had gaps less than two seconds long.
Poor knowledge of stopping distances.	Driver interviews	79% of drivers underestimated distance needed to stop safely at speed of 60 km/h.
Pedestrian accidents. Pedestrians' knowledge of using roads safely poor.	Pedestrian interviews	Before crossing: 58% said look before crossing,  61% said walk on footpath.

After the site visits, improvement schemes were designed and implemented at selected sites. Although the recommendations were predominantly engineering solutions, it was clear from the accident and road side survey that an integrated approach was needed at most of the sites; for example, the use of road signs at a junction to improve behaviour would need accompanying enforcement and educational programmes; and this approach was therefore encouraged.

### 3.1.1 Hazardous road location, an example: Kilometre 60.

Not all of the 18 sites in Table 2 were appropriate for low-cost treatment, and

some were ruled out of the study because they were being generally improved as part of an extensive engineering up-grading programme for the road.

The site at kilometre 60 was typical of the remaining suitable sites which were selected for evaluation. Its accident problems were representative of other sites on the road and, apart from the accident countermeasures, no other changes were planned within the time span of the study (an important consideration for the monitoring programme).

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 the large village on the eastern side of the main road.

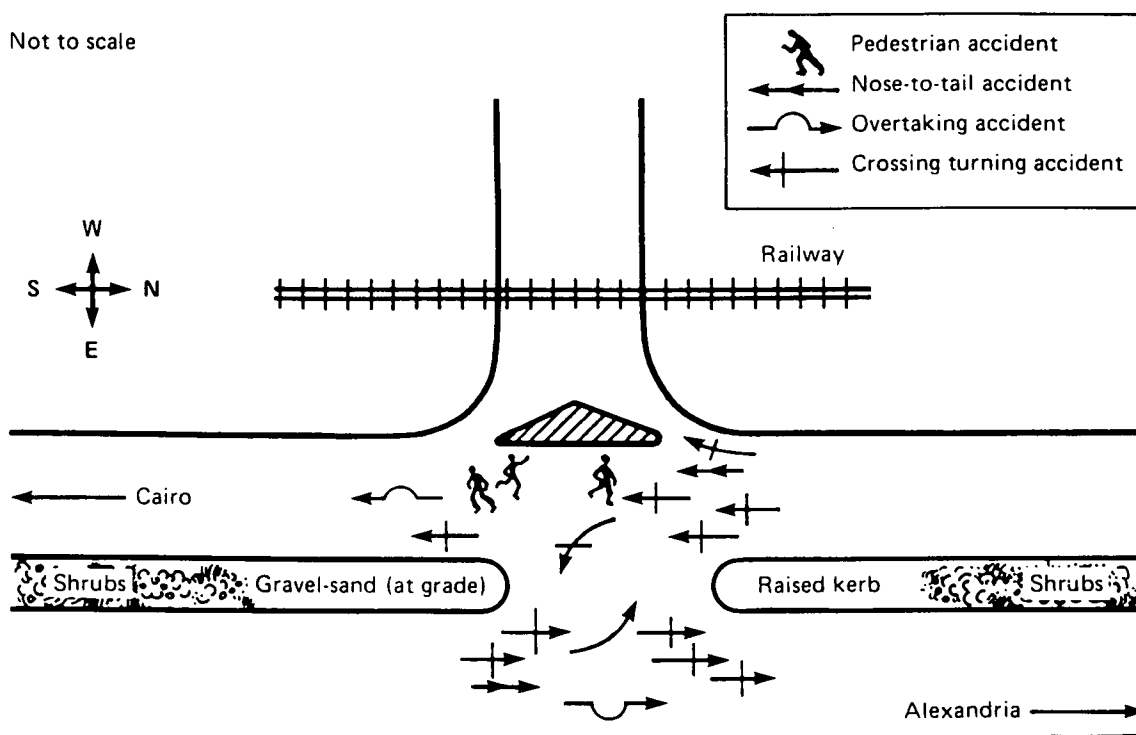


Fig.1 Collision diagram for junction at kilometre 60

Although there were 'Stop' signs for vehicles on the minor road, there were no warning signs of any kind for drivers on the main road. Lamp posts were provided but only those around the railway crossing were working, i.e. lighting on the main road was no longer functioning. Trees lined the western edge of the road and large advertising hoardings had been erected on the eastern side which could cause vision problems.

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. Sixteen per cent were 'nose-to-tail' accidents.

### 3.1.2 Kilometre 60; remedial measures.

Information available for kilometre 60 included:-

- 1) police accident reports,
- 2) MAAP output, including 'Stick diagram analysis',
- 3) survey and observed data, and
- 4) the site check list.

Analysis of the data showed that there was no one dominant accident type at kilometre 60 and, as might be expected, more than one factor was associated with most of the accidents. Thus results from a number of the surveys listed above, and in Table 3 were relevant and had to be considered when deciding a suitable remedial measure for this site. In view of the poor driving behaviour in Egypt, self-enforcing corrective measures were given priority over solutions such as signing and road marking. The remedial measure had to be one that would:-

- 1) prevent main road vehicles from using either side of the island by driving over the at-grade median when turning into the minor road (see Figure 1),
- 2) help protect pedestrians crossing the main road,
- 3) protect main road vehicles waiting to turn,
- 4) provide vehicles using the side road with safe egress and exit, and
- 5) improve nighttime visibility.

The engineering solution adopted involved geometrical changes to both major and minor roads. On the main road a relatively long central island was installed which was shaped to give protection to vehicles waiting to turn (see Figure 2).

This 'safety' area could also be used by animals and animal-drawn vehicles that moved between the village on one side of the road and the fields on the other. By making the island long and wide pedestrians, who previously had been unprotected, had a substantial area on which to stand when waiting to cross the road. The island was also designed to make it difficult for turning traffic to pass on the wrong side of the minor road island. In addition overhead direction signs were erected on the main road.

On the minor road, the entrance and exit slip roads were widened and lengthened but no extra signing was provided on this road. Improvements to street lighting were not carried out as they were considered to be too expensive and likely to result in maintenance problems. Consequently, no deliberate action was taken to improve nighttime accidents, but it is hoped that the general improvements to the site will also help reduce those occurring during the hours of darkness.

Although the monitoring programme is in progress and it will be some time before sufficient data are available to assess the effectiveness of the remedial measures taken. It is of interest to note that when the remedial measures were installed, provisional figures showed that, on average, the cost of an accident

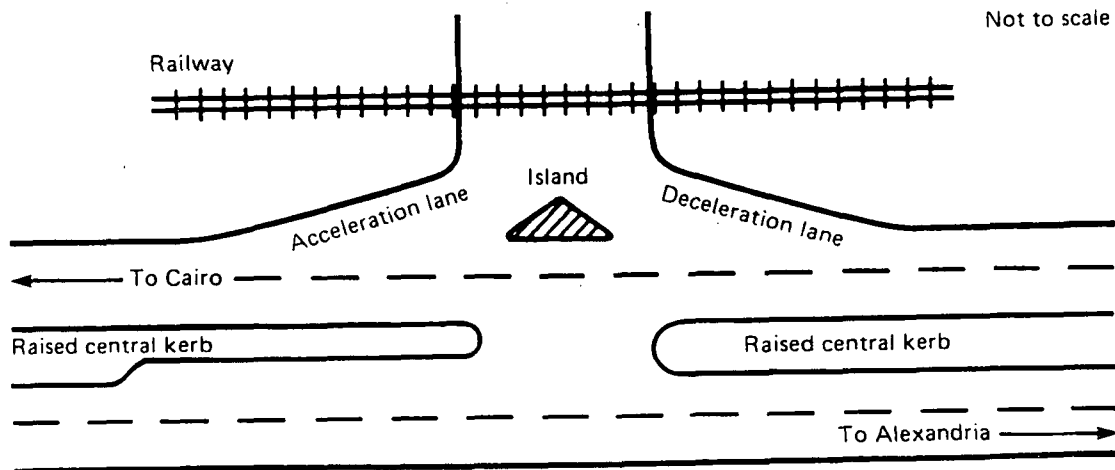


Fig.2 General layout showing accident site with low-cost changes

was approximately £6000 in Egypt. The figure made no allowance for 'pain grief and suffering'. The total cost of improving the site was estimated at between £3000-£3500 and thus it can be seen that by preventing just one accident in the first year, the First Year Rate of Return would be in the order of 200 per cent.

### 3.2 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 transport in Pakistan. It has a long standing and serious pedestrian accident problem and one of its most disconcerting statistics is the number of people killed and injured on its roads. For instance, in 1987, 588 died on the roads with pedestrians being the largest casualty group comprising 54 per cent. Seventy three per cent of all pedestrian casualties were injured whilst crossing the road.

Provision of safer crossing places was therefore a priority. At-grade pedestrian crossings (zebras) are plentiful in Karachi but studies of driver behaviour indicated that virtually no drivers stopped for pedestrians waiting at the

crossings. Consequently few pedestrians used them. Also a few pelicans or 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) supporting the view that low vehicle speeds reduce both the number and severity of accidents.

### 3.2.1 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 perhaps to a greater extent than is really necessary at some locations where dimensions of humps are rather severe. However, it was considered that incorporating this type of self-enforcing device with a raised pedestrian crossing facility may be an ideal remedial measure for Karachi.

To promote consistent driver behaviour and awareness, a standard layout was considered essential so that drivers receive the same advance warning cues for this new type of crossing. The layout proposed is shown in Figure 3. 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 a tactile 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:

- (i) 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.
- (ii) 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 be better at judging 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.
- (iii) 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.
- (iv) 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 (ie. the reason for their deceleration), pedestrians should be less likely to go unnoticed.

Seven sites were selected for the above type of treatment and two for pelican crossings from the Immediate Action Plan. Selection of sites for the Plan was made on the basis of suitability, often where at-grade crossings already existed,

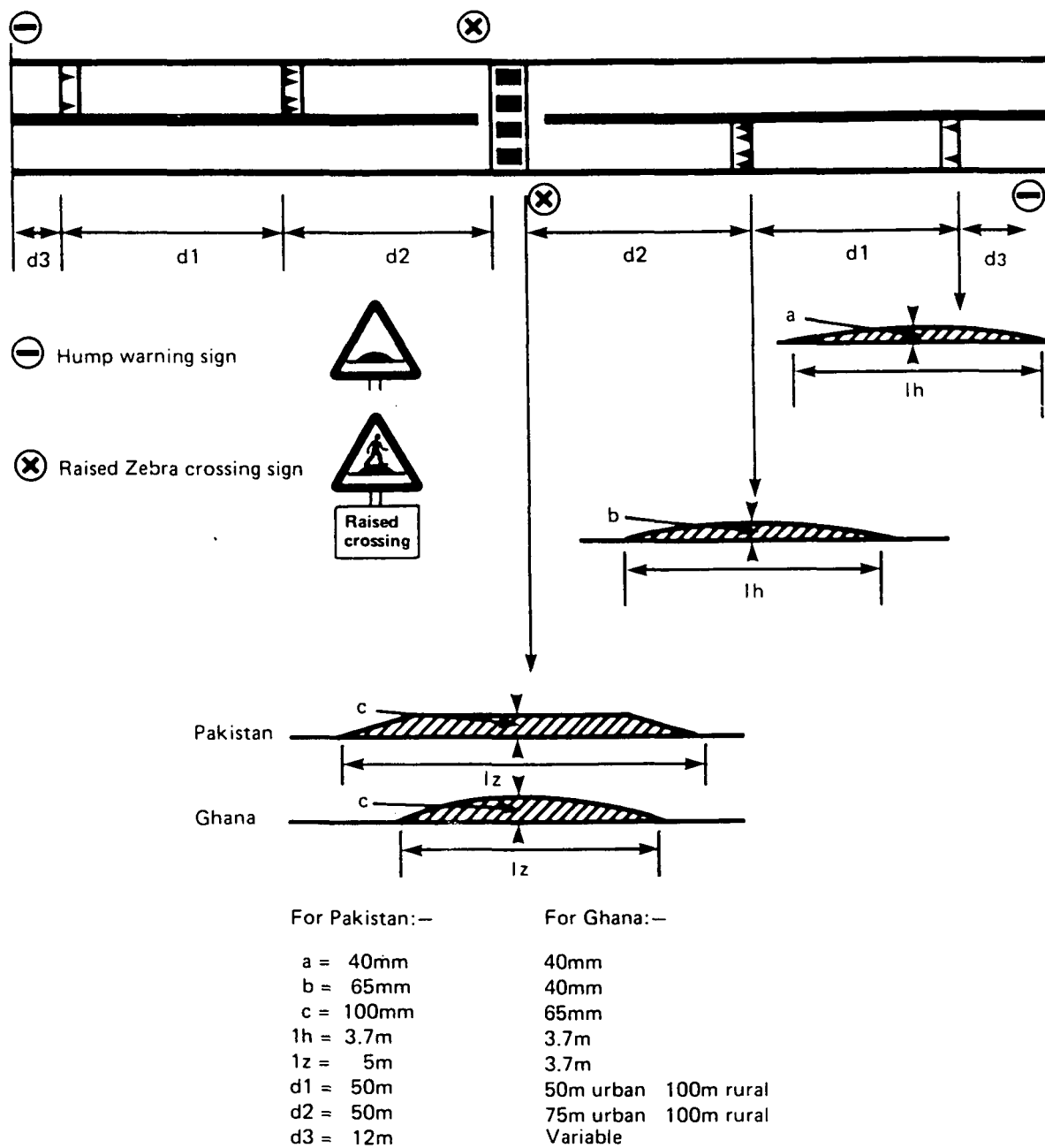


Fig.3 Proposed layouts for raised Zebra crossings in Pakistan and Ghana

rather than of the worst accident blackspots in Karachi (see Table 4 for reported accident rates). Six of the sites were on urban dual or three-lane carriageway roads where mean approach speeds for cars ranged from 35 to 55km/h. With the exceptionally high flows, particularly at sites 1 to 4, and relatively large carriageway widths (see Table 4), crossing the road on foot was often a difficult and hazardous task.

TABLE 4.

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.

3.2.2 Surveys carried out:

As with all accident remedial treatments there is the need for adequate evaluation of their effect. This means 'after' period surveys should duplicate as closely as possible the original or 'before' measurements. Thus a standard daily schedule was rigorously followed at each site where one-day surveys were carried out. These covered five, one-hour observation periods for vehicle and pedestrian peak and off-peak hours of 0830 and 1600 hours, on Sunday to Thursday. As Pakistan is an Islamic country, no surveys were carried out on Fridays. 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, pedestrian flows, crossing times and their delays whilst waiting to cross.

The pedestrian counts were made in the vicinity of the proposed new crossing and also areas 50m each side in order to determine whether more pedestrians are attracted to the crossing. The other pedestrian measurements monitor whether the situation has been improved for pedestrians by reducing their delay on the kerbside and exposure to risk whilst crossing the road. Vehicle journey times over the 200-300m section that included the new installation are being monitored to assess the approximate economic disbenefit 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.

All the above surveys were also carried out at three 'control' sites where no alterations are scheduled for the next few years. These were for comparison with the improved sites so that any external influences that might affect road accidents, for example, changes in travel patterns, fuel costs, levels of enforcement etc., can be accounted for in determining the true effects of the remedial measure.

### 3.3 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 like the UK, USA etc). 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).

The project was started in late 1988 with the introduction of TRRL's Microcomputer Accident Analysis Package on which the Ghana's road accident data base will be stored. Backcoded 1987 and 1988 police records from the Ashanti region were used to identify and select 10 high accident sites for treatment. In parallel to this project the BRRI and the TRRL agreed to carry out a joint study to assess the effectiveness of these improvements.

#### 3.3.1 Remedial measures proposed:

The ten sites comprised five rural and five urban blackspots as listed in Table 5. The sites were selected using the two year's of accident data on

TABLE 5.

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.

computer; an example of the urban/suburban blackspot road sections (or links) is shown in Figure 4.

LISTING THE WORST ACCIDENT SITES			
-----			
ACCIDENT FILE:	ASH87		
	ASH88		
CONDITIONS SET:	NONE		
			<u>Improvement site</u>
			<u>(no. in Table 5)</u>
-----			
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.4 MAAP listing of the worst road sections in Kumasi (1987 and 1988 data).

All the rural and suburban sites are on sections of trunk roads where new high quality road surfaces were applied shortly before 1987. It is thought that vehicle speeds have risen sharply on these sections, creating new blackspots, especially where they pass through roadside villages where no pedestrian facilities have been provided.

Seven of the sites selected appear to have pedestrian accident problems and a system of warning humps with raised zebra crossings, similar to that previously described for Pakistan, has been proposed (see Figure 3).

The Ghanaian highway authorities were concerned about the possibility of drivers encountering the humps at high speeds owing to the generally low flows (see Table 5), particularly on the rural roads, and also that the humps will produce unacceptable delays to drivers. They have therefore adopted lower humps and slightly different types of layout to those to be used in Karachi, as shown in Figure 3. The differences include 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 will be used at some rural sites where approach speeds are high.

The remaining three sites are all bends where single vehicle accidents 111 predominate, often occurring in wet conditions. The proposed treatment for these sites includes the introduction or re-instatement of edge-line and centre-line markings, triangular bend warning signs and chevron boards. The installation of countermeasures is scheduled to take place during the first part of 1990.

### 3.3.2 Surveys carried out:

The same type of roadside surveys carried out in Pakistan have been replicated at the above raised crossing sites. At the bend sites, traffic counts and entry speeds are being monitored. Two rural and three urban control sites having similar traffic and layout characteristics to the above blackspot sites are also being monitored. They are not scheduled for improvement within the next few years and will be used as 'controls' against which the improved sites can be compared.

## 4. 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. Thus 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:-

- i) a good road accident database both for planning road safety improvements and for research;
- ii) a systematic approach for carrying out road safety improvement schemes; and
- iii) 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.

## Acknowledgements.

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