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Road accidents in developing countries—urban problems and remedial measures

by

G. D. Jacobs and I. A. Sayer

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Department of Transport

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**ROAD ACCIDENTS IN DEVELOPING COUNTRIES —
URBAN PROBLEMS AND REMEDIAL MEASURES**

by

G D Jacobs and I A Sayer

(The text of a paper presented to the Seminar 'Transport Safety in Developing Countries' organised by the International Center for Transportation Studies in Italy, November 1984.)

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ROAD ACCIDENTS IN DEVELOPING COUNTRIES – URBAN PROBLEMS AND REMEDIAL MEASURES

ABSTRACT

This report presents a review of the road accident problem in selected cities in developing countries. It shows, for a number of cities, the distribution of accidents by type of road, class of road user and vehicle involved.

It was found that in the cities studied, the road accident fatality rates (per licenced vehicle) were up to thirty times greater than in cities in the developed world.

Studies of road-user behaviour carried out in a number of Third World cities are described. Results show driver behaviour to be markedly poorer at pedestrian crossings and signal controlled junctions in the Third World cities than at similar sites in two cities in Great Britain.

A range of remedial measures that can be introduced at relatively low cost in Third World cities are described.

1. INTRODUCTION

Studies of road accidents^{1,2} have indicated that accident rates (per licensed vehicle) in developing countries are high in comparison with those of Western Europe and North America. In most European countries the majority of reported injury accidents occur on roads in urban areas, the proportion in Great Britain being particularly high, at over 75 per cent of the total. As stated by Sabey³:—

“While the drama of the high speed crash or multiple pile-up attracts widespread publicity and makes the greatest impact on the public, in terms of hard facts, the largest problem associated with road accidents lies in urban areas where traffic speeds are relatively low. Three-quarters of all injury accidents reported in Great Britain occur on roads restricted to 30 or 40 miles per hour. It is vital therefore to examine under what circumstances these accidents occur and how the problem may be alleviated”

It is interesting to note that in the UK where three-quarters of all accidents occur in urban areas, a similar proportion of the population also live in urban areas. If this is representative of other countries, then where the percentage of the population living in urban areas is low, the proportion of accidents taking place in urban areas might also be expected to be low. Population statistics from 20 developing countries showed that in all cases but one, the majority of the population lived in rural areas and for all these countries combined, the population distribution was 28 per cent urban, 72 per cent rural. In these circumstances the majority of accidents in Third World countries might be expected to occur in rural areas; from Table 1 it can be seen that this is not the case.

TABLE 1

Distribution of accidents by type of area

Country	Year	Urban Percentage	Rural Percentage
Chile	1979	85	15
Ethiopia	1982	61	39
Jamaica	1977	70	30
Jordan	1980	80	20
Korea	1982	75	25
Malaysia	1982	50	50
Pakistan (Sind Province)	1981	62	38
Swaziland	1971	37	63
Turkey	1980	73	27
Zambia	1977	56	44

In only one of the countries for which data were available were there more accidents in rural than in urban areas. It may well be that accidents taking place in rural areas are less well reported than in urban areas. Conversely the high proportion of accidents in urban areas may be due to the fact that the large majority of vehicles in developing countries are based in the urban areas.

Another way of examining the road accidents in Third World cities is to compare fatality rates (ie road accident deaths per 10,000 vehicles registered in each city) with those derived for urban areas in the developed world. Results are given in Table 2.

Fatality rates in the cities of developed countries range from 1.4 in Tokyo, Japan to 2.8 in Greater Manchester, UK. Rates in the Third World cities are much higher and also show much greater variation which may, in part, reflect the unreliability of the basic data. In the Third World cities, rates range from 10 fatalities per 10,000 registered vehicles in Bangkok, Thailand and Hong Kong up to 43 in Seoul, Korea and 45 in Amman, Jordan. The fact that a vehicle is registered in a city is no guarantee that it operates only in that city and results should be treated with a degree of caution. Nevertheless, figures in Table 2 suggest that in comparison with cities in developed countries, those in the developing world have considerably higher road accident death rates.

2. ACCIDENT PATTERNS

In order to obtain some insight into the nature of road accidents taking place in Third World cities (ie types of vehicles involved, casualties by class of road user etc) data were obtained from a limited number of cities and results are presented below.

2.1 *Casualties by class of road user*

Table 3 shows the proportion of casualties amongst the various classes of road user. In few of the cities in developing countries were data collected such that a detailed breakdown of class of road-user could be obtained. Thus class of road-user was often subdivided simply into 'pedestrian' and 'vehicle occupant'. Nevertheless this still

provides some insight into the fact that the proportion of pedestrian casualties is higher in these cities than in urban areas in Great Britain. For example, in Bombay and Addis Ababa the proportion of pedestrian casualties is three to four times higher. Data from Delhi also suggests that occupants of commercial vehicles form a much greater proportion of casualties than in Great Britain.

TABLE 2
Fatality rates in different cities

City	Year	Fatalities	Registered vehicles (thousands)	Fatalities/10,000 vehicles
Addis Ababa	1982	135	33	41
Amman	1980	180	40	45
Bangkok	1983	849	822	10
Bombay	1980	733	239	31
Delhi	1980	663	258	26
Fortaleza	1982	314	136	23
Hong Kong	1983	322	328	10
Karachi	1980	665	250	27
Salvador	1982	494	192	26
Seoul	1982	1091	254	43
Greater London	1982	553	2449	2.2
Greater Manchester	1982	226	779	2.8
Tokyo	1980	392	2860	1.4
Detroit	1982	97	646	1.5
New York	1982	555	2520	2.2

TABLE 3
Casualties by class of road user (expressed as percentage of total)

City	Class of Road User								Total
	Year	Pedestrian	Pedal Cycle	Users of 2-wheeled Motor vehicles	Car/Taxi occupants	Users of Public Transport	Commercial vehicle Occupants	Other	
Addis Ababa	1982	80			20				100
Amman	1981	66				34			100
Bombay	1979	68	5			27			100
Colombo	1980	58		26		16			100
Delhi	1983	36	11	16	3	9	22	3	100
Hong Kong	1983	36	3	10		51			100
Karachi	1981	44		8		48			100
Urban Areas Great Britain	1982	24	10	23	37	4	2	-	100

An earlier study⁴ of pedestrian risk rates in two Third World cities illustrated the greater degree of risk that pedestrians incur in crossing busy shopping streets than in a developed country such as Great Britain, where studies^{5,6} had been made of the risk that pedestrians incurred in crossing busy roads. By dividing the number of personal-injury accidents involving pedestrians on a given section of road in a 2 year time period by the average hourly pedestrian flow a measure of relative risk was obtained.

The absolute level of risk cannot, of course, be measured as this would require a knowledge of the total pedestrian flow across the road in a year. The risk rates obtained were related to the vehicle flow measured on the same sections of road.

In order to obtain similar relationships in Nairobi, Kenya and Surabaya, Indonesia, (work being carried out in 1976) the number of pedestrians crossing busy shopping streets during the period 1000–1200 hours and 1400–1600 hours was obtained together with the vehicle flows on these streets over the same time period. Counts were made during off-peak periods so that valid comparisons could be made with results of a number of pedestrian studies made in Great Britain where counts were made during mid-morning and mid-afternoon. The relative risk rates were then regressed against the average vehicle flow and equations derived which were statistically significant at the 5 per cent level. The results are given in Figure 1 together with the relationship obtained for shopping streets in Great Britain.

It can be seen that the levels of risk in Nairobi and Surabaya were much higher than in Great Britain for similar levels of vehicle flow; the slope of the regression line calculated from the data in Great Britain was less steep than for cities in the Third World. At a flow of 1500 vehicles per hour, for example, the risk rates are 86 and 172 per cent greater in Nairobi and Surabaya, respectively, than in Great Britain; at a flow of 3000 vehicles per hour, the rates are 180 and 260 per cent greater. Thus taking pedestrian and vehicle flows into account, pedestrian accident rates were found to be considerably greater than in Great Britain.

2.2 *Types of vehicles involved in accidents*

Table 4 shows the proportion of vehicles involved in road accidents in the cities for which data were available.

It can be seen that there are considerable differences between the various cities. As might be expected, with the relatively low level of car ownership existing in the Third World, the proportion of cars and taxis involved in accidents was considerably less than in Great Britain. The proportion of two-wheeled motor vehicles involved in accidents varied considerably in the various cities, being as low as one per cent in Addis Ababa and as high as 38 per cent in Surabaya.

In the cities where cycle rickshaws operate, such as Bangalore, Jakarta and Surabaya, the proportion of these vehicles involved in accidents is considerable. Observations suggest there is a tendency for the drivers of these vehicles to disobey traffic regulations (traffic signals, one-way streets etc) and the vehicles themselves provide passengers with little protection.

In the Third World cities both commercial and public service vehicles form a high proportion of the total number of vehicles involved in accidents. Studies in Kenya⁷ and elsewhere have shown that commercial vehicles are commonly used to transport people (particularly to places of work) as well as goods and the numbers of people injured in an accident involving a truck carrying people in this way is often high. See plate 1.

TABLE 4

Vehicles involved in urban road accidents (expressed as percentage of the total)

City	Year	Vehicle Type							Total
		Pedal cycles	2-wheeled motor vehicles	Cars-Taxis	Commercial vehicles	Public service vehicles	Rickshaws	Other	
Addis Ababa	1982	—	1	58	27	8	—	6	100
Bangalore	1977	—	32	19	16	10	23	—	100
Bangkok	1983	—	22	53	12	12	—	1	100
Bombay	1977	—	12	58	16	13	1	—	100
Colombo	1980	4	11	40	25	18	—	2	100
Delhi	1983	12	28	17	18	25	—	—	100
Jakarta	1980	—	3	49	34	5	10	—	100
Salvador	1982	2	5	50	28	7	—	8	100
Seoul	1983	—	6	46	19	29	—	—	100
Surabaya	1980	8	38	18	16	8	12	—	100
Built up Areas Great Britain	1982	8	18	68	2	4	—	—	100

A study⁸ of accident records of a number of public transport undertakings in India showed that buses were involved in about five times more accidents than might be expected from their numbers on the road or from their annual vehicle kilometrage. Fatality rates per million bus kilometres travelled were about six times greater than for public transport in London and over ten times greater than for other cities in Great Britain.

This study incorporated an examination of one complete year's accident records of the Delhi Transport Corporation (DTC). In addition, about 10 per cent of all bus drivers (580) were interviewed to obtain information on their background, working conditions, experience and knowledge of the highway code. This showed that almost all received some form of training from the DTC but relatively little time was spent actually behind the wheel of a vehicle. Questions on the highway code revealed that the understanding of emergency stopping distances was particularly poor.

A survey of the condition of 234 buses (over 10 per cent of the total) in five depots operated by the DTC showed that over 90 per cent had no rear lights, stop lights or side lights in working order and over 47 per cent had no front or rear indicators in working order. Over half the buses examined had either extreme or uneven tyre pressures. Clearly the accident record of the DTC could be improved by improving vehicle condition and driver training.

2.3 The distribution of accidents by class of road

In investigations of the pattern of accidents, urban areas can be conveniently separated into distinct locations with different characteristics. In an earlier analysis⁴ of the distribution of accidents occurring in four Third World cities, numbers of accidents in the central areas, on A roads (urban arterial routes), B roads (primary distributor routes), residential roads and other roads were obtained. The results from these cities are given in Table 5, together with those from towns in Great Britain. From Table 5 it can be seen that the cities of the Third World studied, the percentage of accidents taking place in the central areas tended to be more than in Great Britain; the number occurring in the central area of Kingston, Jamaica being particularly high.

This larger proportion of accidents in the central areas of these cities is probably a function of land-use and social activity, developing countries tending to have the large majority of the shops, businesses and even industry concentrated in the centres of their major cities with less activity on the periphery than is the case in developed countries.

TABLE 5
Accident distribution in the cities studied

City	Central area		'A' Roads		'B' Roads		Other		TOTAL	
	No	%	No	%	No	%	No	%	No	%
KINGSTON (1962)	901	59.0	620 41.0%						1521	100
MOMBASSA (average 1972/73)	188	33.3	100	17.7	112	19.8	166	29.3	566	100
NAIROBI (1972)	540	26.1	392	18.9	668	32.2	472	22.8	2072	100
SURABAYA (1974)	969*	23.8	637	15.6	405	9.9	2067	50.7	4078	100
Average of 3 towns in Great Britain (1971)	398	20.3	661	34.5	288	15.0	579	30.2	1917	100

* Including shopping and business districts

3. STUDIES OF ROAD USER BEHAVIOUR IN THIRD WORLD CITIES

In researching road accidents in developing countries it has, in the past, proved difficult to carry out detailed 'on-the-spot' accident investigations that enable the relative contributions made by the road, vehicle, human factors and environment in road accidents to be assessed. However, in some Third World countries the police have attempted to attribute a main cause to each accident reported (it is likely that a large proportion of all road accidents were not reported) and in the analysis⁹ of results for five countries, road user error was identified as the main cause in at least 70 per cent of the road accidents. The police definitions of main causes may vary considerably from one country to another and it is likely that in many of the accidents there was more than one cause. Thus these figures must be treated with caution; it is probable, for example, that they underestimate the contribution of the road environment. Nevertheless they do support the finding of 'on-the-spot' accident investigations¹⁰ carried out in Great Britain that road-user behaviour is the major contributory factor in road accidents.

Because of the importance of road-user behaviour as a factor in accidents and because of requests made by road safety authorities, preliminary studies⁹ were made by the Overseas Unit, TRRL of road-user behaviour,

mainly at junctions and pedestrian crossings, in selected urban areas in a number of developing countries. Wherever possible results were compared with those of similar studies carried out in Great Britain.

Driver behaviour was observed at 'zebra-type' (ie uncontrolled) pedestrian crossings in five Third World cities and comparisons made with results from studies of behaviour at similar crossings in London and Reading, UK. It was mandatory for drivers to stop for pedestrians on the crossings in all cities studied. It was found that the average proportion of drivers stopping in four of the Third World cities ranged from 10 to 17 per cent whilst in Surabaya the percentage was well under one per cent. The equivalent values in Reading and London were 72 and 40 per cent respectively.

Observations were also made at signal-controlled junctions in the same cities and the proportions of drivers (presented with a free choice) stopping at the red signal were recorded. It can be seen from Table 6 that the percentage of drivers choosing not to stop at the red signal in the Third World cities was greater than in Reading and London. Studies were carried out in Nairobi in 1971 and 1977; the results for 1977 showed a marked improvement over the 1975 value. This surprising result may be due to the fact that the number of signals in the city increased from three to over twenty between 1975 and 1977. Having more signals (and having them set correctly) may have brought about the observed improvement in driver behaviour. It should be noted, however, that in Bangkok, Ankara and Surabaya many junctions were signal-controlled, but behaviour was still poor.

TABLE 6
Non-observance of the red signal in selected Third World cities

City		Number of drivers who had a free choice of stopping or not stopping at red signal	Number of drivers choosing not to stop at red signal	Percentage of drivers choosing not to stop at red signal
Ankara (2 sites)	1974	101	36	35.6
Bangkok (9 sites)	1975	754	391	52.0
Nairobi (2 sites)	1975	203	101	50.0
Nairobi (10 sites)	1977	3045	210	7.0
Surabaya (6 sites)	1975	253	92	36.0
Surabaya (6 sites)	1976	396	130	48.8
Central London (11 sites)	1977	364	22	6.0
Reading Area (19 sites)	1977	726	30	4.1

Recent (unpublished) research carried out by the Overseas Unit, TRRL in Islamabad and Rawalpindi, Pakistan investigated driver behaviour at sites where improvements in road markings were introduced. At major – minor junctions where stop lines were installed, and at sites where double white lines were painted on the centre of the carriageway, driver behaviour was little changed. It may well be that in Third World cities low cost measures such as improved road markings may be much less effective for controlling driver behaviour than in the developed world.

4. REMEDIAL MEASURES

Preliminary studies of road-user behaviour in selected Third World cities have shown that behaviour at traffic signals, pedestrian crossings and also at priority junctions is markedly poorer than in cities in Great Britain. Limited studies have also suggested that the level of knowledge on road safety matters is not high. Whether this poor knowledge and behaviour has an effect on the number of accidents taking place in developing countries is not yet fully established and more research is needed to establish whether such links exist. However, it is possible that remedial measures such as road-user education or publicity, whose benefits have been found difficult to identify and quantify in Europe and the UK, could be far more effective in developing countries where existing standards of knowledge and behaviour are much lower.

Because of their relatively greater numbers in developing countries, children represent a much greater proportion of road accident casualties than they do in developed countries. Thus a comparison of the age distribution of person killed in developed and developing countries¹¹ showed that 20 per cent of those killed in developing countries were aged under 15 whilst the equivalent figure in developed countries was 10 per cent. This points to the values of developing teaching aids for use in Third World countries, similar to those developed for use in schools in Great Britain and other developed countries.

With the generally low standard of road-user behaviour that exists in many Third World countries, which may in turn be due either to a lack of awareness of traffic regulations or to a general "attitude" towards road safety, it is important that adequate traffic law enforcement is provided by the police. Because little research had been carried out in this field it is difficult to assess the potential of police enforcement for accident reduction in developing countries. There is however likely to be considerable potential in these countries, for in many of them the traffic police are not so well trained or equipped as they are in developed countries. Further, in many Third World cities the police are obliged to spend much of their time controlling traffic, with little time available for traffic law enforcement.

The most promising evidence for the road safety benefits of enforcement in developing countries comes from Singapore and Egypt. In Singapore, a combined publicity and enforcement campaign appears to have led to drops of 19 per cent in fatalities and 50 per cent in serious injuries, although there was a rise of 20 per cent in slight injuries. In Egypt a package of police enforcement measures including radar, increased patrols and heavier penalties for traffic offences has had a significant effect on accidents on two major inter-urban roads. On one of these roads there has been an overall reduction in the number of accidents of over 50 per cent.

Perhaps the two most important measures that can be adapted to protect the road user during the course of an accident are the use of seat belts for vehicle occupants, and crash helmets for motorcyclists. There has been growing evidence from the developed world that the compulsory wearing of seat belts results in a significant reduction in injuries, particularly those of a more severe nature. The benefits of wearing a seat belt in any particular accident situation should be similar in both developed and developing countries. In view of the often poorer medical facilities, the benefits could in fact be greater in Third World cities in the case of the more serious injuries. Regretably, few Third World countries have, as yet, introduced compulsory wearing of seat belts.

Motorcycling has been shown to be a particularly dangerous activity. In Great Britain for example the fatality rate (per million vehicle miles travelled) of motor cyclists in 1977 was almost 30 times greater than that for car drivers, despite the introduction of the compulsory wearing of helmets in 1973. As shown earlier, in many Third World cities, motor cyclists are a major casualty group particularly in the countries of South East Asia where motor cycles form a high proportion of the traffic mix.

Wider social and behavioural differences between developed and developing countries must also be considered when assessing the potential for road accident reduction in Third World cities. Thus in many Asian cities three or more people can frequently be observed riding a motor cycle or scooter. See plate 2. The relative risk of such overloading has not been investigated but new legislation and/or stronger enforcement of existing laws would be required if this problem is to be dealt with effectively. Thus in Delhi legislation exists for the compulsory wearing of crash helmets (with members of the Sikh religion being exempt) but the law applies only to the driver of the vehicle; consequently passengers rarely wear crash helmets. As it is common in Delhi to find up to five people (usually the father, mother and children of one family) using a motor cycle or scooter at one time, the law is far less effective than in a similar city in a developed country.

As stated in Section 2, commercial and public service vehicles are involved in proportionately more accidents in Third World cities than is the case in Europe and North America. The way in which these vehicles are used leads to potentially dangerous situations with open lorries often carrying large numbers of workers, and buses carrying people hanging on the outside of the vehicle. See plate 3. Paratransit forms of public transport, cycle rickshaws, shared taxis etc also have a reputation of being dangerous vehicles in which to travel. See plate 4. The accident record of these vehicles could be considerably improved by legislation prohibiting lorries, buses and minibuses from carrying passengers in a dangerous manner. Results from Delhi also suggest that much could be done to improve the safety of passengers in public service vehicles through improved vehicle maintenance and also through improved training of bus drivers.

There has been increasing evidence from the UK and USA that relatively detailed local accident investigation, combined with low-cost engineering remedial measures, can be highly cost-effective. The experience being gained from following this approach in these two countries is of particular relevance to the Third World. In developed countries, a growing emphasis has been placed in recent years on obtaining value for money from money spent on road safety. With their lower gross national products, this must also be an important consideration for developing countries.

Work by Jorgensen and Westat¹² in the US indicated clearly the high benefit-cost ratios that could be obtained from "spot" improvements as compared with continuous widening or overall modernisation projects. The limited data available to them strongly suggested that low-cost projects yield the greatest safety benefit per dollar expended. In London, Landles¹³ showed a similar result and his analysis of schemes confirmed that small inexpensive schemes could have a very marked effect on road safety. In London these included parking restriction, traffic signals, road marking etc. However, in developing countries such countermeasures may be much less effective because, as stated earlier, there is evidence to show that they are less effective in Third World cities owing to poor road-user behaviour. From Section 2, the analysis of casualties by class of road-user suggest that pedestrians are particularly vulnerable in Third World cities and much greater efforts should be devoted to improving their safety perhaps by greater use of guard rails, footbridges and light-controlled crossing facilities. Even more advantageous would be the complete segregation of pedestrians and vehicular traffic by the establishment of pedestrian precincts. In Nottingham¹⁴ UK for example, the pedestrianisation of the central areas led to a 60 per cent reduction in all road accidents in a two year period following implementation of the scheme. In the London Borough of Hackney, the use of barriers on residential roads preventing them from being used as through-routes resulted in a 53 per cent reduction in pedestrian accidents and a 44 per cent reduction in other accidents. Regrettably the authors know of no instances where similar techniques have been used in Third World cities.

Outside central areas of cities only a relatively small proportion of accidents may occur in clusters sufficiently large to justify the use of 'site-specific' engineering remedies. There is a tendency in residential area and often on

arterial routes for accident to be scattered diffusely over the street system. As seen from Table 5 a considerable proportion of accidents in those Third World cities where data were available occurred on arterial routes (A and B roads) and in areas described as 'other' which were predominantly residential.

Work at the TRRL is currently directed towards dealing with this problem and research is being carried out in five cities in England. A preliminary study in Swindon¹⁵ showed that by the use of improved junction design, new or redesigned signal-controlled pedestrian crossings and the banning of right turns, accidents in the study area were reduced by 10 per cent. On 'controlled' sections of arterial roads where no improvements were made, accidents over the same period increased by 29 per cent, whilst on non-arterial routes, accidents remained virtually the same.

It is important that safety features, such as those involving geometry, signing and delineation, be introduced at the design stage rather than be added later, almost as an 'afterthought'. For example, it can often be greatly more expensive to widen the main roads at a T-junction after an accident problem has built up than to incorporate it at the construction stage; this is because after construction it is often found that utility services have to be moved for any local widening scheme.

It has become appreciated in developed countries that planning can have a profound effect upon the level of road safety in a city. The layout of roads in residential areas, for example, has been found to have a major impact upon the level of pedestrian accidents in particular¹⁶. It is now generally acknowledged that the 'grid layout' is not conducive to road safety, particularly because of the large number of cross-roads and the availability of 'rat runs' through residential streets, used by motorists either as short cuts or to bypass main road congestion. Thus at the planning stage of residential areas in Third World cities, consideration should be given to road safety.

Finally, when introducing road safety remedial measures in Third World cities, it is essential that scarce resources are not wasted and that any measures introduced are carefully appraised and an assessment made of their relative effectiveness.

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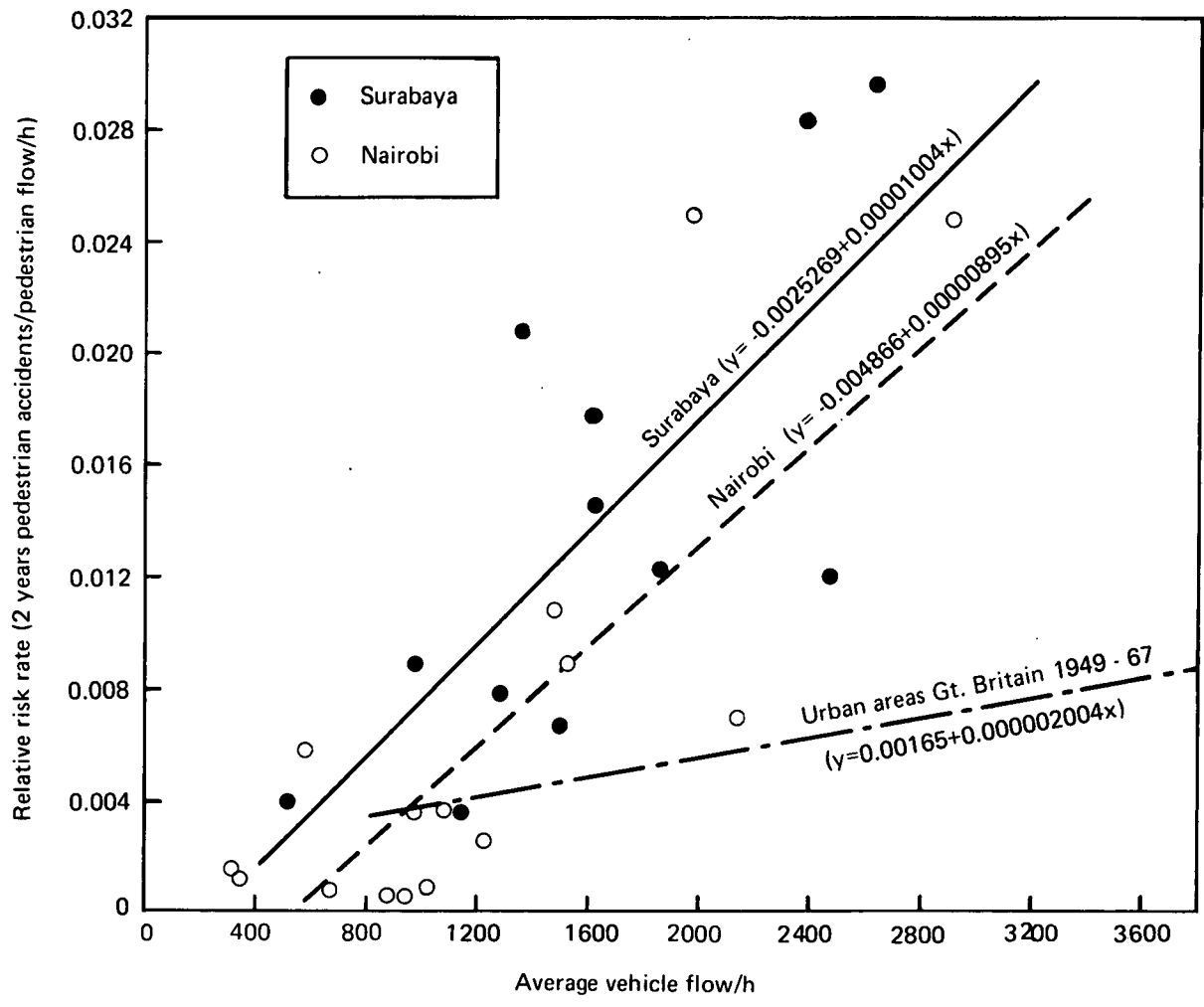


Fig. 1 Central areas – Surabaya (1974) and Nairobi (1972/73) –pedestrian relative risk rates



Neg. no. R375/84/3a

Plate 1 Overloaded commercial vehicles



Neg. no. B1019/82

Plate 2 Motor scooter riders in Delhi



Neg. no. R76/81/13

Plate 3 Overloaded buses



Neg. no. B995/80

Plate 4 Motorcycle rickshaw

ABSTRACT

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ABSTRACT

ROAD ACCIDENTS IN DEVELOPMENT COUNTRIES – URBAN PROBLEMS AND REMEDIAL MEASURES:
G D Jacobs and I A Sayer: Department of Transport, TRRL Supplementary Report 839: Crowthorne, 1984 (Transport and Road Research Laboratory). This report presents a review of the road accident problem in selected cities in developing countries. It shows, for a number of cities, the distribution of accidents by type of road, class of road user and vehicle involved.

It was found that in the cities studied, the road accident fatality rates (per licenced vehicle) were up to thirty times greater than in cities in the developed world.

Studies of road-user behaviour carried out in a number of Third World cities are described. Results show driver behaviour to be markedly poorer at pedestrian crossings and signal controlled junctions in the Third World cities than at similar sites in two cities in Great Britain.

A range of remedial measures that can be introduced at relatively low cost in Third World cities are described.

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