



January 2005

London Road Safety Unit Research Summary No. 3

Pedestrian Guard Railing: A review of criteria for installation

Abstract

There is no uniform policy or guidance on the installation of Pedestrian Guard Railing (PGR) in London despite some moves to remove it in order to improve the street scene. In this study, Transport for London (TfL) commissioned the Transportation Research Group at the University of Southampton to compare the effect of PGR on safety and pedestrian behaviour at 37 sites across London (19 with PGR and 18 without).

Six different site types were studied:

- pedestrian crossings
- signal controlled junctions
- links (along kerb edges)
- central reservations
- transport interchange exits
- school exits.

Collision analysis revealed that, over all sites, pedestrian collisions were lower at sites with PGR. This difference was statistically significant at the 0.05 level.

Total collisions also tended to be lower at PGR sites but the difference was not significant. Observation showed that, overall, pedestrian conflicts were less common at sites with PGR but the difference was not statistically significant. However, the effects of PGR varied between site types: at pedestrian crossings with PGR, pedestrian conflicts were more frequent and at link sites with PGR, total collisions were higher than at sites without. It must be recognised that the number of sites studied of each site type was small.

In terms of behaviour, PGR was associated with higher formal use of crossing points at pedestrian crossings and junctions. It was also associated with reduced pedestrian activity at link sites. These differences were statistically significant. However, improvement in one measure of effectiveness was sometimes counterbalanced by deterioration in another.



Research summary

Study objectives

- Review current practice and criteria for installation of PGR;
- Identify the effects of PGR on pedestrian behaviour, conflicts and collisions;
- Develop criteria for the installation of PGR that promote both safety and pedestrian access (not included in this document).

Background

Current practice

PGR is primarily used to channel pedestrians to formal crossing points and to prevent them from walking on the carriageway or from crossing it at unsafe places. It is used at a wide range of locations in London such as:

- at pedestrian crossings
- at signal controlled junctions
- along kerbs in high density
- shopping areas
- along kerbs to stop people parking
- along central reservations
- at entrances and exits to transport interchanges.

PGR is generally recommended at locations that are deemed 'hazardous'¹ but this is not well defined and there is no single document covering their installation in the UK. Recent guidance stresses the importance of justifying the installation of all PGR as, although it can reduce pedestrian collisions, it can also reduce visibility and footway width,

make access difficult, obscure children and be visually intrusive. The Mayor's Strategy and the Living Streets Initiative encourage the removal of barriers to walking, to improve the street scene and increase convenience for pedestrians. There is a clear need to review how PGR is used in London and the situations in which it is appropriate.

Previous safety research

A study of 16 sites across London in 1983² suggested that renewing or extending existing PGR was more effective in reducing collisions than installing PGR at new sites. Further studies in 1983³ and 1988⁴ of the differential effects of PGR on adult and child pedestrian collisions showed that traditional PGR actually increased child collisions while reducing adult collisions. However, types of PGR that improve visibility at PGR sites were found to reduce casualties three times as much as traditional guard railing.

Another study in 1985⁵ examined the effect of guard railing at 55 Pelican crossing sites in London; some with and some without PGR. Some of the Pelican crossings had been converted from Zebra crossings while others were new installations. It showed that pedestrian collisions were reduced after installation at all sites except where the Pelican crossing was both new and did not have PGR.

Research summary

Methods

- Telephone interviews with engineers in six London boroughs and at TfL were conducted to obtain information on current practice;
- A collision analysis using 36 months data was undertaken for sites with and without PGR. The area included usually covered 50m around the site of interest but varied between site types;
- An observational study using video footage compared pedestrian and vehicle behaviour at a range of different site types. Observations were made for four hours over the same area as was included in the collision analysis.

Site selection

Thirty-seven sites (19 with PGR and 18 without) were selected across five London boroughs (Ealing, Westminster, Hammersmith & Fulham, Hillingdon and the Royal Borough of Kensington & Chelsea). Table 1 shows the number of sites of each type included in the study. To ensure a good range and match of site conditions, the following criteria were taken into account during site selection:

- traffic volume
- pedestrian volume
- land use
- complexity of road layout.

Overall there were no statistically significant differences in pedestrian flows, vehicle speeds and vehicle flows between sites with and sites without PGR.

Table 1. Number of sites of each type

Site type	Number of sites	
	With PGR	Without PGR
Pedestrian crossings	5	5
Road junctions	5	5
Links: High density, retail shopping streets	3	3
Links: Roads with central reservation	2	2
Transport interchanges exit/entrance	2	2
School exit/entrance	2	1
Total	19	18

Research summary

Measures

Safety indices

The safety effect of PGR at different site types was evaluated using:

- total collision numbers over 36 months (2000-2002);
- pedestrian collision numbers over 36 months (2000-2002);
- pedestrian conflict numbers over four hours.

Conflicts were defined as instances when evasive action was observed on the part of a pedestrian or the vehicle or where no evasive action was taken but the time to a potential collision was 1.5 seconds or less. The 'Time to Collision' was calculated by dividing the distance between two road users by the speed of the vehicle. Conflicts were categorised as one of eight different types.

Behavioural indices

Pedestrian and vehicle movements were recorded at each site to determine the effect of PGR on behaviour. This information was used to develop indices of the effectiveness of PGR in encouraging the desired pedestrian behaviour. Because the desired behaviour differed between site types, these indices also varied between site types.

Interview results

In practice, engineers reported that the decision to install PGR rested with the design engineer, as there were no hard rules about the installation. These decisions were site-specific but safety was the main consideration when PGR was installed. More recently, certain boroughs had introduced specific policies to remove street clutter, including PGR. Safety audit recommendations were seen as useful in clarifying a case either for or against PGR.

Safety results

Results over all sites

Table 2 shows the mean number of pedestrian conflicts, total collisions and pedestrian collisions for each site type.

- The average number of pedestrian collisions at sites without PGR over three years was 2.5 times higher than at sites with PGR. The difference was statistically significant at the 0.05 level.
- Pedestrian conflicts at sites without PGR were 1.2 times as frequent as at sites with PGR (non-significant).
- There was no statistically significant difference in the average number of total collisions between sites with and without PGR although the average tended to be lower at sites with PGR.

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Table 2. Comparison of average safety scores for each site type with and without PGR

Site type with or without PGR	Observed pedestrian conflicts over four hours	Total collisions over 36 months	Pedestrian collisions over 36 months
Pedestrian crossings			
With	2.2	3.2	1
Without	1.4	5.0	2
Junctions			
With	1.2	3.8	0.4
Without	2.0	3.8	1.2
Links			
With	2.7	4.3	0.33
Without	4.7	0.7	0.67
Central reservations			
With	0	5.0	0
Without	0.5	3.5	1
Transport interchanges			
With	2.0	0.5	0.5
Without	0	1.0	0
School exits			
With	0	0	0
Without	1.0	2.0	1
Average for all site types			
With (19 sites)	1.5	3.1	0.5*
Without (18 sites)	1.88	3.2	1.2*

* Denotes differences between sites with and without PGR which are statistically significant at the 0.05 level.

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Behavioural results

The effect on behaviour was calculated for each site type.

Pedestrian crossing sites

PGR at pedestrian crossings aims to encourage pedestrians to use the designated crossing area.

Measures of behaviour

Pedestrian behaviour at pedestrian crossings was recorded and categorised in three ways:

- A. Pedestrians who used the crossing within the designated crossing area
- B. Pedestrians who either started or ended crossing within the designated crossing area
- C. Pedestrians who crossed away from the crossing.

These measures were combined to develop three effectiveness indices:

1. Utilisation rate $(A+B)/(A+B+C)$: The proportion of all pedestrians crossing the road who used the crossing in some way
2. Correct use rate $(A)/(A+B)$: The proportion of crossing users who crossed within the designated crossing area
3. Formal use rate $(A)/(A+B+C)$: The proportion of all crossing pedestrians who crossed within the designated crossing area.

Results at pedestrian crossings

- Table 3 shows that mean Utilisation rate and Formal use rate were significantly higher at sites with PGR;
- At sites without PGR Correct use rate increased as traffic flow increased.

Junction sites

At junction sites PGR aims to encourage pedestrians to use formal crossings.

Measures of behaviour

The same behavioural indices were used for junction sites as were used for pedestrian crossing sites (i.e. Utilisation rate, Correct use rate and Formal use rate).

Results at junctions

- Table 4 shows that Formal use rate and Correct use rate were significantly higher at PGR sites;
- A negative correlation existed between Correct use rate and pedestrian flows i.e. as the number of pedestrians increased, the Correct use rate decreased.

Table 3. Average behavioural indices for pedestrian crossing sites with and without PGR

All pedestrian crossings	Vehicle flow (vph)	85th percentile speed (mph)	Pedestrian Flow (pph)	Utilisation rate (%)	Correct use rate (%)	Formal use rate (%)
No PGR	1430	32.3	184	81.9***	91.6	74.6***
With PGR	1215	29.6	245	94.2***	94.1	88.7***

*** Denotes differences which are statistically significant at the 0.001 level.

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Table 4. Average behavioural indices for junction sites with and without PGR

All junction sites	Vehicle flow (vph)	85th percentile speed (mph)	Pedestrian Flow (pph)	Utilisation rate (%)	Correct use rate (%)	Formal use rate (%)
No PGR	733	18.1	480	84.8	94.3**	79.5*
With PGR	1597	23.3	293	88.2	99.5**	87.8*

* Denotes differences which are statistically significant at the 0.05 level

** Denotes differences which are statistically significant at the 0.01 level

Link and central reservation sites

At these sites PGR aims to discourage pedestrians from crossing the carriageway at unsafe locations.

Measures of behaviour

All pedestrian movements that were either on the carriageway or on the central reservation within a 50m stretch of road were defined as pedestrian activity and recorded. The effectiveness of PGR was measured using the Activity rate (the number of pedestrian movements per hour), with lower Activity rates suggesting that PGR was more effective.

Results along link and central reservation sites

- Table 5 shows that the pedestrian Activity rate at link sites with PGR was significantly lower than at link sites without PGR;
- Nevertheless, a total of 29 people climbed over the railing at PGR sites. The level of climbing activity varied between sites.

Table 5. Average Activity rates for link sites with and without PGR

All central reservation and link sites	Vehicle flow (vph)	85th percentile speed (mph)	Activity rate (pph)	Total number climbing
No PGR	1455	24.5	109*	n/a
With PGR	1780	27.0	19*	29

* Denotes differences which are statistically significant at the 0.05 level

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Transport interchange and school exit/entrance sites

PGR at exits/entrances aims to guide pedestrians to a nearby pedestrian crossing and deter them from crossing directly outside exits. These sites were considered as a separate site type because they were characterised by high numbers of pedestrians and sudden fluctuations in pedestrian activity.

Measures of behaviour

All pedestrians who used the school entrance and those pedestrians who crossed the road to use the transport interchange had their movements categorised in one of three ways:

- A. Pedestrians who crossed using a nearby formal crossing.
- B. Pedestrians who crossed directly at the exit (not using crossing).
- C. Pedestrians who crossed away from both the exit and the crossing.

Three behavioural indices were developed using this information:

1. Direct crossing rate $B/(A+B+C)$: The proportion of pedestrians who crossed at the exit;
2. Crossing rate at associated pedestrian crossing $A/(A+B+C)$: The proportion of pedestrians who crossed at the associated pedestrian crossing;
3. Crossing rate at other location $C/(A+B+C)$: The proportion of pedestrians who crossed elsewhere.

Results at entrances/exits

- Table 6 compares the mean behavioural indices for sites with and without PGR.
- Small sample sizes meant that no tests of statistical significance could be performed.
- Differences in site layout also meant it was difficult to determine the cause of any differences between sites.

Table 6. Average behavioural indices for exit/entrance sites with and without PGR

All exit/entrance sites	Vehicle flow (vph)	85th percentile speed (mph)	Pedestrian flow (pph)	Crossing at other location (%)	Crossing rate at crossing (%)	Direct crossing rate (%)
No PGR	957	19.8	300	6.8	91.8	1.4
With PGR	872	25.0	289	7.0	93.0	0

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Conclusions

When all sites are considered together, those with PGR have lower average levels of pedestrian conflict, lower total collisions and statistically significantly lower pedestrian collisions. However, the effects of PGR differ between site types. This may be caused by the different sample sizes for each site type.

At pedestrian crossing sites, the average numbers of total collisions and pedestrian collisions were lower at PGR sites but pedestrian conflicts were higher. At junction sites with PGR, pedestrian conflicts and collisions were lower than at sites without PGR and there was no difference in average levels of total collisions. This suggests possible safety benefits in installing PGR at pedestrian crossings and junctions.

PGR at link sites reduces pedestrian activity on the carriageway but also results in the more risky behaviour of jumping over PGR by those determined to cross. At these sites, the average numbers of pedestrian conflicts and pedestrian collisions were lower than at sites without PGR. However, the average number of total collisions was higher, suggesting that an improvement in pedestrian safety may be counterbalanced by a reduction in safety for all road users.

At transport interchange sites with PGR, pedestrian conflicts and pedestrian collisions were higher than at sites without PGR and total collisions were lower. There was also no significant reduction in the number of pedestrians who crossed directly at the entrance. Because of the small sample size, care should be taken when generalising these results. However, at similar sites, when making decisions on installing or removing PGR, consideration should be given to the positioning of the pedestrian crossing relative to the interchange entrance as this might be as effective as PGR in improving safety and channelling pedestrians.

At the three school sites sampled, PGR improved all aspects of safety and reduced the proportion of pedestrians crossing directly at the exit. Although only based on a small sample, this suggests that PGR should be installed at such sites.

Next steps

The Department for Transport is currently undertaking a similar study of PGR at 70 sites.

Comparison of the results from the two studies will help test the reliability of the findings summarised here.

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Selected references

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