ON-STREET PARKING MANOEUVRES AND THEIR EFFECTS ON DESIGN

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Abstract -Vehicle manoeuvres when entering or leaving on-street parking can be a contributory factor to causing congestion. Little explicit attention has been given to these manoeuvres and their indirect potential effects on the moving traffic. In the design of new on-street parking facilities, or in carrying out improvements to existing ones, the aim should be to reduce the time required to conduct these parking manoeuvres which results in temporary disturbance to the traffic stream. This study describes the characteristics of vehicle on-street parking manoeuvres based on data collected from two sites with different on-street parking layouts. The results indicate that parking involving reversing requires longer manoeuvring times. Reversing is always needed in the case of angle parking in order to complete the parking or unparking manoeuvre. This is undesirable especially when reversing takes place while the road is operating under high levels of traffic flow. Suggestions were made for the design of parking stalls depending on traffic conditions and vehicle composition.

Background

Previous studies[1,2] have shown that the capacity of the road network can be reduced considerably if parking facilities and locations are not selected and controlled properly. On-street parking can cause severe delays especially on busy roads resulting in stop-start situations in the traffic stream. The reduction of the available width of the road to accommodate on-street parking is one of the main factors influencing road capacity. Safety is another factor which needs to be considered in design. One study showed that on-street angle parking is less safe than that of parallel parking[3]. This may be attributed to the lack of adequate visibility for the driver during the reversing manoeuvre.

In this study, the time required for manoeuvring to park, or unpark, has been looked into in more detail. This will help in a better understanding of the process of parking and consequently influence the design of these facilities and their provision. Data were collected from two sites and the results were analysed and presented.

Selection of Sites and Method for Data Collection

Two sites within Greater Manchester, UK have been selected; one with parallel and the other with angle on-street parking stalls. It should be noted that the parking stalls for the second site are at right angles (i.e. 90°) to the kerb. The stall size for the first site is 210cm x 610cm whilst the second is (2x270)cm x 410cm. Other differences observed between the two sites were that drivers have to pay for parking for the first site using the on-street parking meters, whilst parking is free of charge for the second site.

Video recording techniques were used to acquire traffic details from both sites. A domestic camcorder was adapted using an external battery to enable continuous recording for approximately 8 hours in each case to allow appropriation of the necessary information for different traffic conditions. A character generator was also used to provide the actual time recorded on the tapes in hours, minutes, seconds and 1/100 second. The video tapes were then played back to obtain the necessary information. The data were stored in computer files and later accessed using spread sheet software for the analysis.

Results and Analysis of Data

On-street parking can be divided into two groups: legal and illegal. Illegal on-street parking refers to those vehicles not parked in the designated parking locations (i.e. parking stalls) and are parked illegally on double yellow lines. This has only been observed in the first site and can be attributed to the fact that in order to park legally in the designated areas, drivers have to find an empty stall and pay the appropriate fee (depending on the length of time allowed to park). Therefore, some drivers may take the risk and park illegally on the road (usually for a short duration). It was decided to limit the analysis presented in this work to consider legal parking only. This will allow possible comparisons between the two types of parking for the two sites (i.e. parallel and angle on-street parking) when parking manoeuvre times are considered.

Parking manoeuvre times are the length of time required by vehicles to enter or leave the parking stalls. This is measured from the centre of the lanes to the parking stalls in the case of entering a stall. In the case of leaving the stall, it is measured from the parking stall until the vehicle starts travelling in the traffic stream. Different manoeuvre patterns have been identified on entering or leaving the stalls. These patterns are influenced by many factors including type of parking, presence of other parked vehicles in the adjacent stalls, size of stalls, vehicle type, drivers' manoeuvring preference to reverse when entering or leaving a stall and traffic flow levels. Tables 1-4 show the main manoeuvring patterns for the different scenarios together with the calculated mean, standard deviations and range for each case. Not all patterns are included in these Tables and only those with a significant number of occurrences are shown.

Table 1: Entering manoeuvre pattern and times (in seconds) for parallel on-street parking

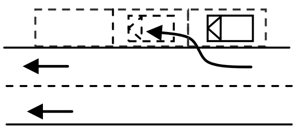
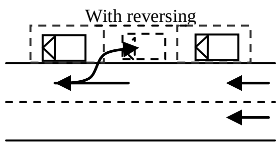
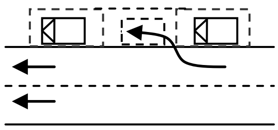
Pattern I				Pattern II				Pattern III				
												
Mean	St.Dev	Sample	Range	Mean	St.Dev	Sample	Range	Mean	St.Dev	Sample	Range	Total
3.7	1.2	19	2.2-6.2	21.2	12.2	26	2.3-55.2	7.7	9.8	23	3.2-49.9	68

Table 2: Leaving manoeuvre pattern and times (in seconds) for parallel on-street parking

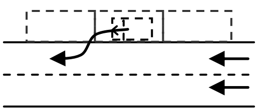
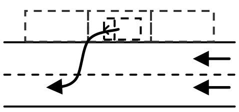
Pattern I				Pattern II				
								
Mean	St.Dev	Sample	Range	Mean	St.Dev	Sample	Range	Total
6.3	2.5	63	2.3-15.2	5.5	2.0	10	4.0-10.1	73

Table 3: Entering manoeuvre pattern and times (in seconds) for angle on-street parking

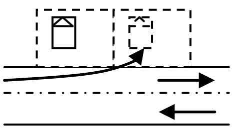
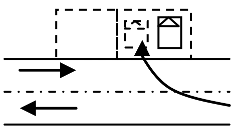
Pattern I				Pattern II				
								
Mean	St.Dev	Sample	Range	Mean	St.Dev	Sample	Range	Total
4.9	4.2	96	2.1-42.2	4.9	1.0	48	3.4-7.8	144

Table 4: Leaving manoeuvre pattern and times (in seconds) for angle on-street parking

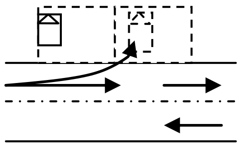
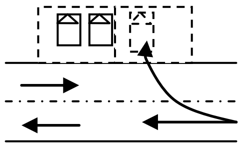
Pattern I				Pattern II				
With reversing 				With reversing 				
Mean	St.Dev	Sample	Range	Mean	St.Dev	Sample	Range	Total
9.6	5.2	121	4.2-45.6	11.8	3.8	20	6.0-21.6	141

Table 1 shows that for parallel parking, the mean values for those patterns involving parking between two parked vehicles are relatively high. Parking involving reversing (i.e. Pattern II) has the highest mean of all. Similar means are also observed for the cases involving leaving manoeuvres for parallel parking, as shown in Table 2. However, not all cases are presented here due to lack of data. The standard deviation and ranges are relatively high for those cases involving reversing and / or parking between two parked vehicles. This is expected because of the difficulties experienced by some drivers to conduct such manoeuvres.

For the case of angle parking, Tables 3 and 4 show that mean value for entering manoeuvre time is nearly half that for leaving. Also the standard deviation for leaving manoeuvres are higher than those for entering in each of the relative cases. This can be attributed to the required reversing manoeuvres when leaving the parking stall, in addition to the obscured visibility from the driver's position who is trying to leave the parking stall and proceed ahead in the traffic stream.

An attempt has been made to compare the above results with available results from previous studies. A study by Johnston[4] in 1960 showed that manoeuvre times of parallel on-street parking were longer than those of angle parking with an angle of 37.5° to the kerb (i.e. the average driver required 32 seconds to reverse into a parking stall and 12 seconds to reverse out of an angle parking stall to join the traffic stream). Those results are somewhat different from the current study (i.e. 21 seconds and 10 seconds, respectively). However, it is not easy to draw a straightforward comparison between the two studies. This is because of the difference in the angle for the chosen site in the current study (i.e. 90° compared with 37.5°). Other factors include the effect of improvements and changes in the design of motor vehicles of today, compared with those in the early 1960's; type and size of vehicle, size of parking stall, traffic volume and traffic composition.

As the level of traffic volume increases, there are only relatively small gaps in the moving traffic. The potential of occurrence of congestion caused by on-street parking, in particular, manoeuvring times to enter or leave a parking stall, will increase. These manoeuvres could create temporary bottlenecks in the traffic stream caused by the sudden change in speed of the moving traffic which could result in unsafe behaviour. Therefore, careful attention should be given in the design of on-street parking locations and size of parking stalls to reduce the effect on moving traffic.

Final Remarks and Suggestions

There are differences in drivers' choice of manoeuvring patterns when entering or leaving on-street parking. These patterns have a substantial effect on the required time for manoeuvring. An increase in manoeuvring time could be a contributory factor to creating congestion, increasing delay and reducing safety.

Observations suggest that parking manoeuvres involving reversing while entering or leaving a parking stall require longer times than those without reversing. In the case of parallel parking, reversing is sometimes necessary when parking between two parked vehicles while it is always required in the case of angle parking. This should be taken into consideration when designing new on-street parking facilities or when carrying out improvements to the layout. The parking stalls should be designed so that reversing manoeuvres are minimised and the available space for parking is optimised to provide the required number of stalls.

For the optimisation process, O'Flaherty[5] suggested alternative designs to the size and arrangement of parking stalls (based on average size of cars in the UK), as shown in Figures 1 and 2. There are obvious differences between the two alternative designs. The design shown in Figure 1 provides 5 spaces for cars while that in Figure 2 gives 6 spaces. Both designs occupy similar lengths of about 30 metres. Another benefit of using the arrangements shown in Figure 2 is that the effects of reversing manoeuvres to enter the parking stalls on traffic stream would be minimised. The provision of a manoeuvring space of 1.2metres with paired stalls allows drivers to complete the critical part of their parking manoeuvre (i.e. reversing) within the allocated stall spaces. This will result in lower disturbance to the main traffic stream.

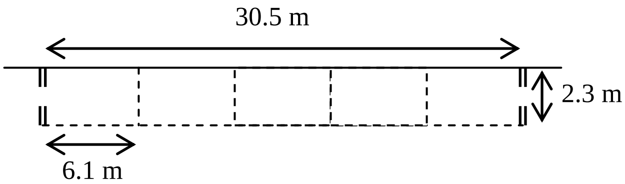


Figure 1: Individually marked parking stalls
(Source: O'Flaherty[5])

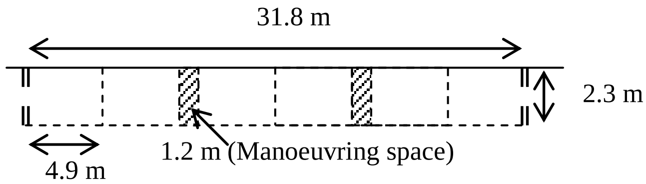


Figure 2: Paired parking stalls
(Source: O'Flaherty[5])

The designs shown in Figures 1 and 2 are commonly used in metered parking where stalls are clearly marked. Another alternative design is shown in Figure 3 (using similar length as that shown in Figure 1) where individual stalls are not marked. This is commonly used when parking is operated and controlled by a "pay and display" method.

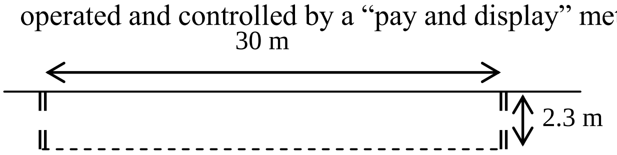
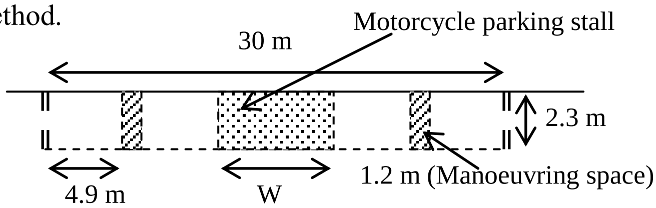


Figure 3: Unmarked parking stalls



(W: width depends on the percentage of motorcycles)

Figure 4: Proposed design for high % of motorcycles

Careful attention should also be given to the design of parking stalls when there are wide varieties of vehicles' size and type within the traffic stream. In countries such as Indonesia, the use of motorcycles in the city is relatively high. A report by BPS Indonesia[6] suggests that the proportion of motorcycles in the traffic stream between 1987 and 1998 reaches 70%. This is compared with less than 1% in the current study. Therefore, special provisions for motorcycles should be made when designing on-street parking facilities in places such as Indonesia, as proposed in Figure 4.

References

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