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# REVISED WALKWAY CAPACITY USING PLATOON FLOWS

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**Abstract:** The objective of this study is to develop the basis for revising average flow values to platoon flow, which would then be used to determine the Level of Service. Capacity usually means the maximum ability of a facility to accommodate flows, not only in vehicle traffic design but also walk paths. The analysis conducted in this study is to evaluate the relationship between average flow and platoon flow based on existing site conditions. 50 sites of walkway were selected and the data collection was collected in term of pedestrian flow, non-platoon flow and platoon flow. Computations for walkways were based on 15 minutes pedestrian counts. 15 minutes period were taken just for the reason of stability. The effective width of the walkway was also as certain to determine the value of flow in terms of pedestrians/min/ft. From this data, the analysis involved determining pedestrian volume, and the timing of non-platoon and platoon periods. The relationship between the average and platoon flow was establish based on graphical terms where a maximum platoon flow lines was drawn in the Platoon Flow versus Average Flow graph. Based on this line, a mathematical relationship between Average Flow and Platoon Flow was established.

**Key Words:** platoon, level of service, walkway capacity, flow.

## 1. INTRODUCTION

Every trip begins and ends with walking. Yet the pedestrian is often forgotten among the traffic planner's other concerns. Both his access problems and internal circulation problems have been generally neglected, although the later has received more attention recently. In both instances, the main concern is to provide the pedestrian with a safe, direct, and pleasant walking experience.

Platoons represent involuntary groupings of pedestrians, and as such, should be distinguished from groups who walk together by choice. Of course, a voluntary group of people strolling leisurely together and chatting can cause others to form a platoon when opportunities for passing are limited.

Capacity usually means the maximum ability of a facility to accommodate flows, not only in vehicle traffic design but also walk paths. This study aims to define the level of service based on platoon flow. This would require modifying the existing Level of Service which definition uses average flow.

This is necessary because currently the design of walkways and the determination of the level of service of walkways are generally based on average flow. However pedestrian flows also occur in platoon, resulting in very high flows in the first minute followed by low flows in the next minute. Therefore, modifying the existing Level of Service by introducing the use of platoon flows is needed.

Facilities designed which are based on average flows are generally found to be under designed for a sizable portion of time i.e. when platoon flows occur. In order to resolve this problem, there is a need to design walkway based on platoon flows, which can be done if a relationship between average flows and platoon flows is derived.

## 2. OBJECTIVES

The main objective of the proposed study is to define a relationship between flows in platoon and the average flow. This relationship would be presented in terms of a graph which links average flow to flows in platoon. The study involves measuring at selected locations, average flow and flows in platoon. The location selected would range from unimpeded, impeded, constrained and crowded walk-paths.

Average flow would be measured by counting the number of pedestrians over a period of time (15 minutes) allowing the determination of persons per foot per minute. Whereas, platoon flows will be measured by timing platoons and counting when there is a wave of above-average density in the pedestrian stream.

Another method of platoon flow measurement involves timing gaps in flow and counting stragglers walking during the lull periods. Then the non-platoon time and flow will be subtracted from the total time and total flow to determine the platoon flows in persons per foot per minute. Following which the relationship between platoon flows and average flows will be determined graphically.

Other objectives of this study are as follows:

- To determine the average flow over a period of time at selected walkways.
- To determine the flow rate in platoons for the same sites.

## 3. LITERATURE REVIEW

Flow and space standards for walking facilities and their application were the focus of this study. Consistency was shown in a comparison of work done by various researchers on speed, flow, and density relationships. Levels of comfort at different fractions of maximum capacity were defined. Platooning was evaluated and related to average conditions. Levels of service of platooning were postulated based on available space per pedestrian.

**Pedestrian Paths**

The actual width of paths needs to be related to the particular pedestrian flows that operate. For example, the capacity of a path used primarily at peak hours may be quite different from the casual requirements of shoppers. There are three broad categories of walkway paths. The primary path, with minimum width of 23 feet; the secondary path, with a clear width of 11.5 feet; and perhaps certain minor paths used for access only, with minimum width of 6.5 feet. In many cases, it may be necessary to increase comfort and convenience by assisting the movement of pedestrians with mechanical devices such as moving belts.

**Space related to speed and flow**

The spacing between pedestrians, like the spacing between vehicles, is related to the speed at which the objects are moving. More space is required for faster movement. The relationship of space requirements, speed of movement, and rates of flow has been studied by a number of researchers. There are Older (1968), Fruin (1970), Oeding (1963), and Navin and Wheeler (1969) findings traditional equation describing traffic flow is

$$\text{Flow} = \text{Speed} * \text{Density} \tag{1}$$

Where,

Flow = number of moving objects crossing a unit of channel width in a unit of time
Speed = number of units of distance the moving objects pass in a unit of time
Density = number of moving objects per unit of channel area.

They found that if the objective was to maximize pedestrian flow, regardless of speed or comfort, the space allocation per pedestrian should be between 5.2 and 9.1 $ft^2$. Letting space allocation drift below that level will lead to a crush, the crowd will grow in size as long as the number of incoming pedestrians is greater than what the bottleneck can release.

**Pedestrian Space Requirements**

This study recommends for design a simplified body ellipse of 50 cm x 60 cm for standing areas, with a total area 0.3 $m^2$, or roughly 108% of the ellipse suggested by Fruin (1971). This study also recommends a body buffer zone of 0.75 $m^2$ for walking, near the upper end of the buffer zone range provided by Pushkarev and Zupan (1975a).

**Service Levels**

Studies concerning the distribution of pedestrian speeds under conditions of free choice have been carried out by numerous observers, among them Fruin (1970), Mac Damon (1967), Gehl (1968), and Hoel (1968). Biological limits govern both how fast and how slowly people can walk. The various investigators agreed that virtually no one would voluntarily select speed faster than 400 ft/min, or slower than 145 ft/min.

There are other indicators of congestion, besides the inability to maintain a freely selected speed. An important one is the inability to choose one's path freely across the traffic stream. A related indicator is ability to pass slow-moving pedestrians, which Oeding (1963) found to be relatively unrestricted at space allocation of more than 36 ft$^2$/pedestrian. He found that the ability to pass was considerably restricted in the range between 18 and 36 ft$^2$/pedestrian. At lower space allocations, he found that passing was possible only by physically pushing the slow-moving person aside.

The current Highway Capacity Manual (HCM) defines capacity as 6 ft$^2$/ped (about 0.56 m$^2$/ped). Alex Sorton of Northwestern University suggests that the current Level of Service (LOS) A space requirement is excessive, and should be reduced from 130 ft2/ped (12 m2/ped) to 60 ft2/ped (5.6 m2/ped). As a point of comparison, Table 1 below compares LOS values in the HCM with those reported from other researchers.

Table 1. Walkway Level of Service (LOS) thresholds by space (m2/ped) and flow rate (ped/m/min)

| | HCM | Fruin | Pushkarev -Zupan | Brilon | Polus et al. | Tanaboriboon-Guyano |
|---|---|---|---|---|---|---|
| LOS | (m2/ped) | (m2/ped) | (m2/ped) | (m2/ped) | (m2/ped) | (m2/ped) |
| | | | ≥ 49 | | | |
| A | ≥12 | ≥3.2 | 12-49 | ≥10 | | ≥2.38 |
| B | 3.7-12 | 2.3-3.2 | 12-4 | 3.3-10 | | 1.60-2.38 |
| C | 2.2-3.7 | 1.4-2.3 | 4-2 | 2-3.3 | 1.67[b] | 0.98-1.60 |
| D | 1.4-2.2 | 0.9-1.4 | 1.5-2 | 1.4-2 | 1.33-1.66 | 0.65-0.98 |
| | | | | | 0.8-1.33 | |
| E | 0.6-1.4 | 0.5-0.9 | 1-1.5 | 0.6-1.4 | 0.5-0.8 | 0.37-0.65 |
| F | 0.6 | 0.5 | 0.2-1 | 0.6 | unknown | 0.37 |

| LOS | (ped/min/m) | (ped/min/m) | (ped/min/m) | | (ped/min/m) | (ped/min/m) |
|---|---|---|---|---|---|---|
| | | | ≤1.68[a] | | | |
| A | ≤6.6 | ≤23 | 1.6-7.0 | | | ≤28 |
| B | 6.6-23 | 23-33 | 20-7 | | | 28-40 |
| C | 23-33 | 33-49 | 20-33 | | ≤40[b] | 40-61 |
| D | 33-49 | 49-66 | 33-46 | | 40-50 | 61-81 |
| | | | | | 50-75 | |
| E | 49-82 | 66-82 | 46-59 | | 75-95 | 81-101 |
| F | vaT. | vaT. | 0-82 | | unknown | 101 or var. |

[a]Instead of HCM LOS designations "A"-"B"-"C"-"D"-"E"-"F", Pushkarev and Zupan use "Open" "Unimpeded" "Impeded" "Constrained" "Crowded" "Congested" "Jammed"
[b]Instead of HCM LOS designations "A" "B" "C" "D" "E" "F", Polus et al. use A-B-C1-C2-D

*SOURCES: Fruin (1971); Pushkarev and Zupan (1975b); Brilon (1994); Polus et aI.(1983); Tanaboriboon and Guyano (1989).*

Tanaboriboon and Guyano (1989) developed LOS standards for Bangkok, Thailand. Although probably not useful for most areas of the United States, their data in the table highlight the importance of cultural values and physical characteristics on LOS breakpoints. The authors noted that one result of the difference between Thai and American LOS standards was that pedestrian facilities in Thailand could accommodate higher flows at a given LOS.

Based on the above findings, this study recommends the changing of the capacity thresholds as we can see in Table 2 below.

Table 2. Recommended Thresholds Walkway Level of Service

| LOS | Flow rate (ped/min/ft) |
|---|---|
| A | ≤ 2 |
| B | ≤ 7 |
| C | ≤ 10 |
| D | ≤ 15 |
| E | ≤ 25 |
| F | Variable |

**Walkway width**

Some people in the past have described a pedestrian "lane" as a strip as narrow as 56 cm, however; the lane is irrelevant to capacity calculations. The lane can only be meaningful if one wish to calculate how many people can walk abreast or pass each other simultaneously along a walkway of a given width. The lateral spacing to avoid interference with a passing pedestrian, according to Oeding (1963) was at least 75 cm.

Multiples of about 0.75 m can be used to calculate clear walkway width for a given number of people to walk abreast in a voluntary group and to be able to pass a group, but clear walkway width deserves more emphasis. People shy away from walking along the very edge of a curb or against building walls. Therefore, dead space along the edges of a walkway must be excluded from effective width when one calculates design flow. Also excluded must be a strip preempted by physical obstructions, such as light poles, mailboxes, and parking meters, although their exact effect on pedestrian flow has not been sufficiently investigated. The area preempted by standing pedestrians also is not available for walking.

**Pedestrian Traffic Flow Relationships**

Given the comfort zone requirements for Americans, it seems that walkway capacity lies between 4,000 and 5,000 pedestrians/h/m. For simplicity, this study recommends an assumed capacity of 75 pedestrians/min/m (4,500 pedestrians/h/m). This study also recommends an assumed speed at capacity of 0.75 m/s. In addition, this study recommends the pedestrian buffer zone space of 0.75 $m^2$/ped for a capacity threshold. It provides the following relationship among fundamental pedestrian flow parameters (Fruin, 1971):

$$v = \frac{S}{M} \tag{2}$$

Where:

v = flow or volume;
S = speed; and
M = pedestrian area module ("space") = 1/density.

The unit of pedestrians/min/m width represents a pedestrian flow rate (pedestrian/min), normalized by width (m or ft). While the unit of $m^2$/ped (or $ft^2$/ped) represents the average space available (in $m^2$ or $ft^2$) per pedestrian.

The conditions at maximum flow represent the capacity of a walkway facility. Research reported by Pushkarev and Zupan (1975a) that all movement effectively stopped at 2 to 4 $ft^2$/ped (about 0.2 to 0.4 $m^2$/ped). Pedestrians can choose their preferred walking speed with low pedestrian volume, but both flow and speeds declined under crowded conditions. Pushkarev and Zupan (1975b) noted in earlier research that pedestrians preferred a body buffer zone space of 0.27 to 0.84 $m^2$ and that "unnatural shuffling" began when space fall below 0.75 $m^2$/ped.

**Platoons**

Table 3 summarizes the initial research on platoons. Pushkarev and Zupan (1975b) noted that earlier research found that the ability to pass slow-moving pedestrians was relatively unrestricted at space modules above 3.3 $m^2$/ped, difficult between 1.7 and 3.3 $m^2$/ped, and essentially impossible below 1.7 $m^2$/ped. Pushkarev and Zupan also compared average flow rates with possible flow in platoons.

They found that no difference between the flow conditions at any service level, except at that point in "Impeded" flow (approximately LOS B) when platoons begin. The Interim Materials on Highway Capacity contained platoon flow criteria. This work, relying on the "rule of thumb" mentioned earlier, simply rewrote the recommended walkway values up one level for platoons. The current HCM, which does not contain a platoon flow service level table, uses different walkway values for average flow rate and space at most service levels than those in the Interim Materials.

Table 3. Platoon-adjusted walkway Level of Service (LOS) thresholds

| | Flow Rate | | | |
|---|---|---|---|---|
| | Pushkarev-Zupan | | Interim Materials | |
| LOS | (ped/min/m) | (ped/rnin/ft) | (ped/min/m) | (ped/rnin/ft) |
| A[a] | ≥ 1.6[b] | ≥ 0.5 | 6[c] | 2 |
| B | 15-20 | 4.5-6 | 6-20 | 2-6 |
| C | 20-33 | 6-10 | 20-33 | 6-10 |
| D | 33-46 | 10-14 | 33-46 | 10-14 |
| E | 46-59 | 14-18 | 46-59 | 14-18 |
| F | 59 | 18 | 59-82 | 18-25 |

[a]Instead of *HCM* LOS designations "A"-"B"-"C"-"D"-"E"-"F", Pushkarev and Zupan use "Open"- "Impeded"- "Constrained"- "Crowded"- "Congested"- "Jammed"
[b]Values given by Pushkarev and Zupan for flow rates and space are within platoons
[c]Values given in the *Interim Materials* for flow rates and space are under average flow conditions

*SOURCE: Pushkarev and Zupan (1975b)*

Therefore, one cannot simply apply the values listed in the Interim Materials to the current HCM. One can develop platoon flow LOS criteria based on a synthesis of the relationship between average and platoon flow. For LOS A, this report uses Pushkarev and Zupan's relationship between average and platoon flow and defines this breakpoint to be just before the discontinuity, at 1.6 ped/min/m (0.5 ped/min/ft), identical to the "Open" flow of Pushkarev and Zupan. For LOS B through D, this study applies metricized "rule of thumb" to *HCM* walkway values, by subtracting 13 ped/min/m from walkway flow rates. For LOS E, and thus LOS F, this report uses the highest platoon flow rate found by Pushkarev and Zupan, 59 peds/min/m. The LOS shown at each flow rate or pedestrian space level represents the walkway LOS (based on Interim Materials service levels) under these average flow rate when platoons arise.

**Platoon Effect**

Short-term fluctuation is generally present in any traffic flow that is not regulated effectively by a schedule, and its underlying cause is that participants in a traffic stream arrive at a given spot at random. Thus, purely by chance, one minute a section of sidewalk may receive many pedestrians, and the next minute it may receive few. In an urban situation, this random unevenness is exaggerated by 3 additional factors.

First, its passing is impeded because of insufficient space, faster pedestrians will slow down behind slow-walking ones, and a random bunch of pedestrians will snow ball into a platoon. Second, Light Rail Transit and, to a lesser extent, elevators and buses release groups of people in very short intervals of time with pauses during which no flow may occur. Until they have a chance to dissipate, these groups proceed together more or less as a platoon. Finally, and most importantly, traffic signals release pedestrians in groups that tend to proceed as groups as groups along a sidewalk.

One of the reasons why platoons have been neglected by previous researchers, it may be that they were hard to define. Research done by Pushkarev and Aupan (1979), tried both of positive and a negative definition. In the positive definition, platoons were timed and counted when it appeared to the observer a wave average density was swelling up in the traffic stream. In the negative definition, gaps inflow were timed and the stragglers walking during these lulls were counted; then the non-platoon time and flow were subtracted from total time and flow to determine performance in platoons.

The most important influence on platoons at the street surface is traffic signals. Platoon generally follows signal cycles. To explore a different situation, counts also were taken during the morning arrival period at light-flow Light Rail Transit station exits. When platoons were strictly defined, 75 percent of the flow occurred in platoons 47 percent of the time, which is about 1.6 times the average flow rate. When platoons were more loosely defined, 95 percent of the flow occurred in platoons 60 percent of the time, which is also about 1.6 times the average flow rate.

**Revised Service Levels**

Platoon flow occurred at certain average flow rates so that the characteristics given in Table 4 can be applied to platoons. A comprehensive way of going about this would be to plot a distribution for a range of pedestrian densities by type of facility and time of day showing the percentage of people that have to walk at densities exceeding the average and by what amount the average is exceeded. Then a cutoff level can be chosen to serve a specified percentage of the walkers at a specified level of service.

Table 4 Characteristics of Average Flow and Flow in Platoon

| Quality of Flow | Average Flow | | Possible Flow in Platoon | |
|---|---|---|---|---|
| | Space per Pedestrian (ft2) | Flow Rate (ped/min/ft) | Space per Pedestrian (ped/min/ft) | Flow Rate (ped/min/ft) |
| Open | > 530 | < 0.5 | > 530 | < 0.5 |
| Unimpeded | 530 to 130 | 0.5 to 2 | 530 to 60 | 0.5 to 4.5 |
| Impeded | 130 to 40 | 2 to 6 | 60 to 40 | 4.5 to 6 |
| Constrained | 40 to 24 | 6 to 10 | 40 to 24 | 6 to 10 |
| Crowded | 24 to 16 | 10 to 14 | 24 to 16 | 10 to 14 |
| Congested | 16 to 11 | 14 to 18 | 16 to 11 | 14 to 18 |
| Jammed | < 11 | More than 18 | < 11 | More than 18 |

Note: 1 pedestrian/ft = 3.27 pedestrian/m
1 ft/min = 0.305 m/min.

The equation of this line relating maximum platoon flow to average flow is:

$$\text{Platoon Flow} = 4 + \text{Average Flow} \tag{3}$$

The form that this equation takes indicates that platooning has a much greater impact on light flow volumes than heavy flow volumes. Minimum walkway standards that can be applied regardless of actual flow volume are necessary when flows are small because large platoons could arise suddenly. An entrance to an apartment house may experience zero flow for many minutes until an elevator arrives with a platoon.

As average flow increase space requirements do not grow proportionally but rather at a retarded rate, which is fortunate for the design of such high-intensity pedestrian facilities as shopping malls or transportation terminals. There are clear economies of scale in providing walkway space.

## 4. METHODOLOGY

The methodology of this study was in terms of finding an acceptable location and measuring the walkway width. Upon completion of these tasks, the survey would commence. 50 sites were selected randomly in Kuala Lumpur. After data collection, the results were analyzed using the excel-graphical method. Finally, the average flow over a period of time at selected walkways, and the flow rate in platoon for the same sites were determined.

Based on the data analysis, conclusions can be drawn with deriving a graphical relationship between average flows and platoon flows which in turn can be used to determine the actual Level of Service.

### Data Collection

The initial step of this study was the selection of the site location. The sites selected should have pedestrian volumes ranging from moderate to heavy volumes. The bases of site selection were as follows:

a) The selection of 50 pedestrian walkway, where pedestrian volumes will be counted and platooning effects, will be observed.
b) Each site will be measured for duration of 15 minutes for the reason of stability.
c) Shopping Street, Merdeka Square, Ampang Area, and the main entrance to the shopping complexes are example of locations that would be selected for surveys.
d) Video cameras would be setup at the selected sites to record the data.
e) The volume of pedestrians would be counted from viewing the results of videotape.
f) The relevant data, which includes volume of people walking in platoon, non-platoon of pedestrians and the total volume of pedestrians would be counted.

### Data Check

Manual counts would also be undertaken at the site to verify the result of the video count. Further more practical on-site observations would also be recorded. Overall the data collection would involve:

a) Counting the total number of pedestrians.
b) Counting the volume that walk in platoon.
c) Determining the average flow of pedestrian and platoon flow.
d) Measure the width of the walkway for the selected sites.

**Method of Analysis**

a) Calculate the total flow of pedestrians, based on 15-minute intervals for each site location.
b) The total flow of pedestrians over the time period will be the average flow of pedestrians over the width of the walkway. The unit of the flow is 'persons per foot per minute'.
c) The volume of pedestrians in platoon is the total number of pedestrian average pedestrian flow minus the non-platoon pedestrians.
d) The modified level *of* service based on platoon flow can be plotted based on the relationship between the average and platoon flow.

**Calculation in the Analysis**

The final and the *most* important stage of this study was analysis stage. Data used *for* analysis in this study were collected from 50 different sites. The data collected were presented in the *form of* table. The quality *of* flow was classified into levels *of* open flow, unimpeded flow, impeded flow, constrained flow, crowded flow, congested flow and jammed flow.
In this study, the average flow was calculated based on:

$$\text{Average flow} = \frac{\text{Total number } \textit{of} \text{ pedestrian}}{\text{Time period taken}} \qquad (4)$$

On the other hand, the platoon flows can be determined from

$$\text{Platoon flow} = \frac{\text{Total number } \textit{of} \text{ pedestrian - non-platoon pedestrian}}{\text{Total time taken - non-platoon period}} \qquad (5)$$

From the collected data, the average flow and platoon flow were calculated by substituting the data into the formulas shown above (Equation 4 and Equation 5). In this process the information were taken for another analysis by way using graphical method *to* define the average flow rate versus platoon flow. These would be useful to design the pedestrian walkway based on the graphical method. Plotting average flow versus platoon flow was useful because the resulting relationship can be represented as a reasonable approximation of reality.

The analysis provided results in the form of a graphical method, which relates average flow rates to platoon flows. The graphical result would be in the design of the pedestrian walkway. Forecasted volumes of pedestrian flow would then be linked to forecasted platoon flows, which would be used to estimate the level of service.

## 5. RESULTS AND ANALYSIS

Computations for walkways were based of peak 15-min pedestrian counts. A pedestrian movements of both platoon and non-platoon movement were described in terms of pedestrian demand over the available space within a period of time. The site measurements for each location involved establishing the 15-min pedestrian count; measurement of platoon flow and non-platoon flow periods; and walkway width in feet

The average flow and platoon flow volumes in pedestrian/min/ft were established using Equation 4 and Equation 5.

### Relationship between Average flows and Platoon flows

The relationship between average flows and platoon flows was described in graphical terms based on the values calculation in Table 5. This graph is presented in Figure 1. The line establishes the relationship between maximum platoon flow rates and average flow rates. It is a mathematical expression, which relates maximum platoon flow rates to average flow rates. The line drawn is the upper limit line, which establishes the maximum platoon flow value for a particular average flow rate. The line drawn is not from curve fitting of regression equation. Therefore, no validation required for this relationship.

The mathematical expression of the line shown in Figure 1, which relates maximum platoon flow rates to average flow rates is as follows

$$\text{Platoon Flow} = 5 + \text{Average Flow} \tag{6}$$

The equation takes a constant increment added to the average flow. It shows that platooning has a relatively greater impact at low volumes than at high volumes. This is because gaps between platoons tend to fill up as flow increases. This equation can be used in general analyses where specific platooning data are not available.

## 5. CONCLUSION

Based on the results of the analysis, it was found that the relationship between maximum Platoon Flow and Average Flow to be:

$$\text{Platoon Flow} = 5 + \text{Average Flow}$$

Hence, when designing for a particular Level of Service it would be necessary to modify the average flow value to platoon flow.

For instance, the Highway Capacity Manual provides that the Level of Service D falls between the ranges of 11-15 ped/min/ft. However, if designing for Level of Service D taking into account the platoon flow, then the volume of average flow should be between the ranges of 6-9 ped/min/ft. Only then can Level of Service D be achieved when platoon flow occurs.

Table 5 Average flow and platoon flow (only part of the data)

| No | Location | Average flow (Pedestrian/min/ft) | Platoon flow (Pedestrian/min/ft) |
|---|---|---|---|
| C2 | In front of BB Plaza | 5.428 | 10.194 |
| C3 | Bintang Walk | 6.269 | 6.438 |
| C4 | In front of BB Plaza | 9.251 | 12.974 |
| C5 | Bintang Walk | 11.774 | 8.737 |
| C7 | In front of Impiana Hotel | 11.513 | 9.894 |
| C15 | In front of Sogo Complex | 6.697 | 7.057 |
| C28 | Opposite to KLCC Suria | 1.036 | 1.560 |
| C46 | Front of Bangkok Bank | 6.850 | 7.339 |
| C48 | Front of Impiana Hotel | 12.457 | 8.994 |
| C51 | Opposite to BB Plaze | 2.485 | 5.976 |
| C52 | In front of BB Plaze | 3.211 | 3.670 |
| C53 | Bintang Walk | 4.090 | 6.553 |
| C54 | In front of BB Plaze | 8.639 | 9.174 |
| C55 | Bintang Walk | 12.385 | 8.563 |
| C57 | In front of Impiana Hotel | 10.523 | 9.894 |

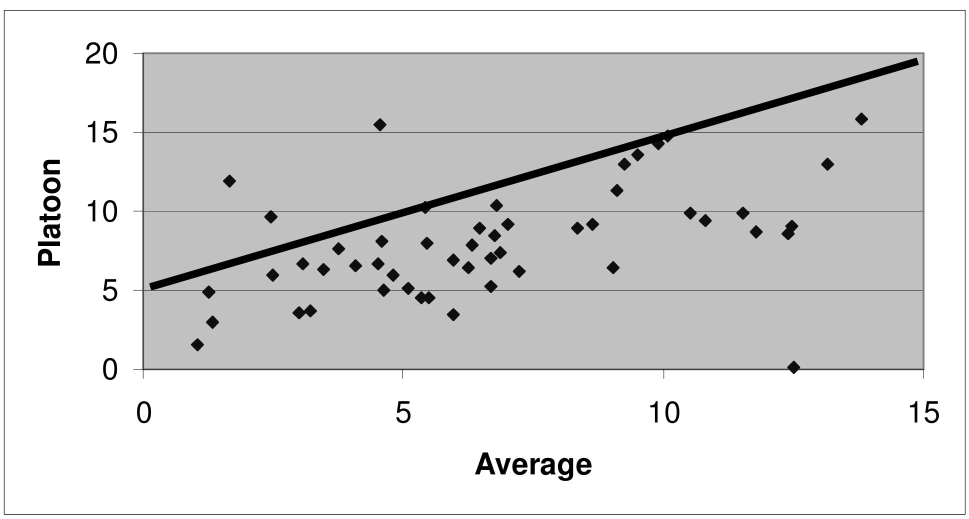


Figure 1 Relationship between Average Flow and Platoon Flow.

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