1. Analysis of the Size

The size of the merge area can be determined by the following parameters:

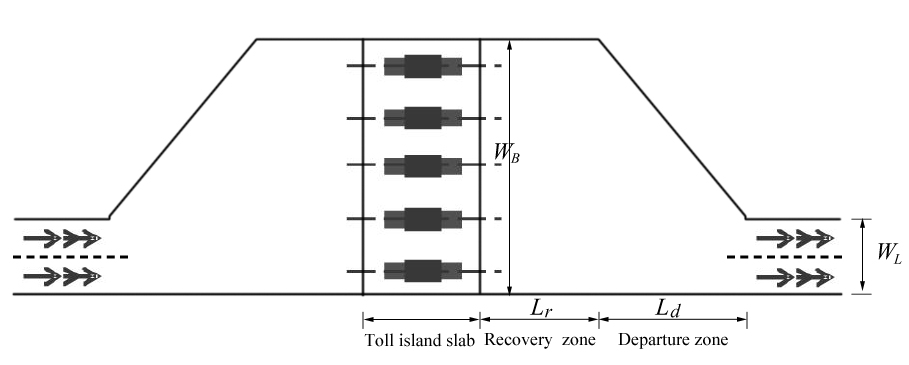
·Total width of typical toll lanes ().

·Length of the recovery zone ().

·Length of total departure zone().

·Width of the exit().

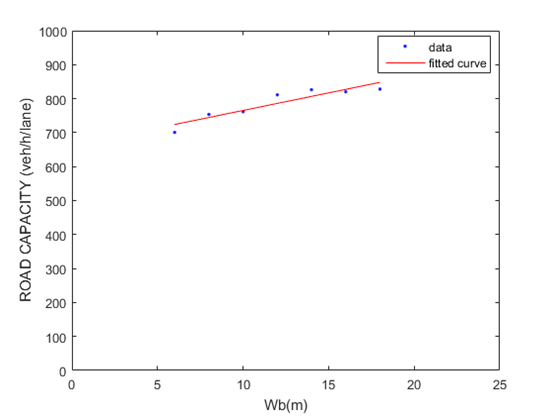
Parameters hereinbefore are shown in Figure 1.



Figure

For the number of travel lanes () is fixed, is constant. Then we are considering the effect of the rest parameters separately. By simulating our model mentioned above via computer program, we can figure out how these parameters affect the maximal throughput of the merge area, that is, .

Figure 2 shows the variation tendency of with the alteration of the width of each tollbooth . Apparently = B. Figure 2 provides a result under the prerequisite that ranges from 6 to 14 while other parameters are fixed.



Figure

We utilize an appropriate Linear Fitting Function Model to address the data, and then get the fitting function of and :

Where, =10.35, = 661.7.

The simulation result indicates that would only be affected by the total width of typical toll lanes () in a small degree. However, increasing will markedly result in a rise in construction costs.

For , the linear fitting image is showed in Figure 3 and the variance of is 36.7188. We can see that causes almost no effect on the merge area capacity.

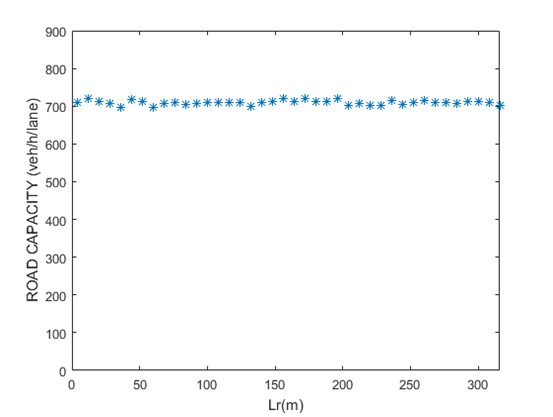


Figure 3 fitting image of Q3max and Lr

Both linear fitting image, and function of and are shown below. There is a negative correlation between and . Nevertheless, the relationship is so faint that enlarging by changing is not functional.

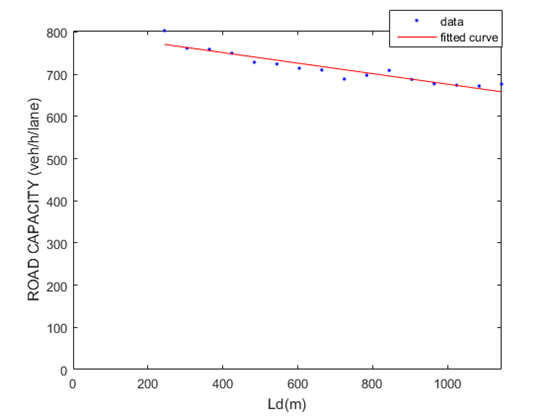


Figure 4 fitting image of Q3max and Ld

Where, =-0.1248, = 801.1.

From discussion above, the size does cause impact on , while the impact is not that obvious. In addition, and should never be constructed too small because it may cause potential safety problems and result in higher accident rate. We will discuss this problem later in Chapter XX.

1. Shape

We propose two types of the plaza shape: series type and parallel type.

1. Series type

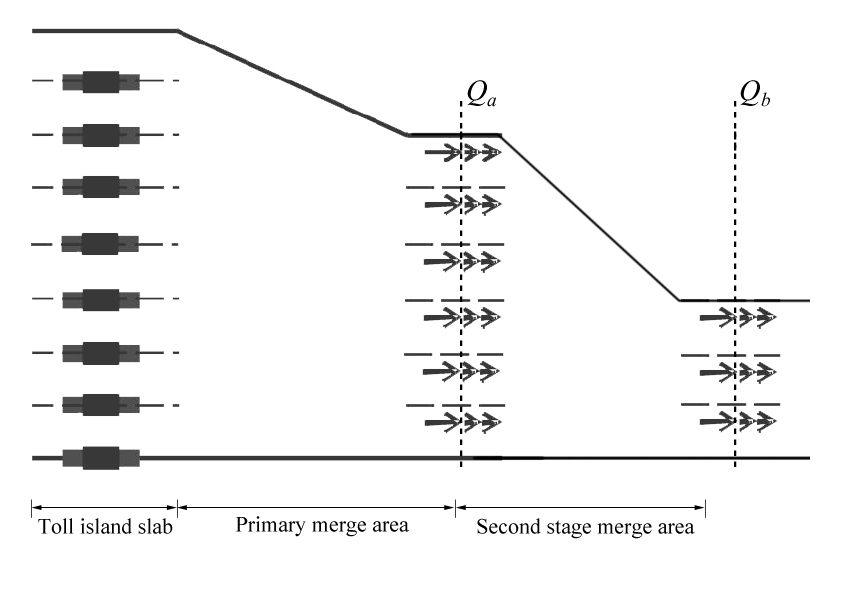
Literally, this type is to connect two or more merge areas in series. Here, we only consider connecting two merge areas. Furthermore, we might as well suppose B=8 and L=3. Specially, vehicles fan in from eight tollbooth egress lanes down to six lanes of traffic, then fan in from six lanes of traffic to three, as Figure 7 shows. 

Figure 7 Series type

According to the Buckets Effect (BE),

, and respectively signify the maximal throughput of the primary merge area, second stage merge area and the whole series-type toll plaza.

We can get Table 1 from simulation results, which indicates the value of the maximal throughput for each traffic line with different B and L (B>L).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B=1 | B=2 | B=3 | B=4 | B=5 | B=6 | B=7 | B=8 | B=9 | B=10 |
| L=1 |  | 882 | 845 | 832 | 796 | 771 | 772 | 736 | 689 | 640 |
| L=2 |  |  | 815 | 789 | 773 | 755 | 720 | 718 | 686 | 659 |
| L=3 |  |  |  | 755 | 758 | 734 | 724 | 709 | 684 | 671 |
| L=4 |  |  |  |  | 724 | 700 | 715 | 695 | 694 | 673 |
| L=5 |  |  |  |  |  | 716 | 695 | 690 | 688 | 673 |
| L=6 |  |  |  |  |  |  | 695 | 688 | 682 | 667 |
| L=7 |  |  |  |  |  |  |  | 682 | 676 | 670 |
| L=8 |  |  |  |  |  |  |  |  | 676 | 660 |
| L=9 |  |  |  |  |  |  |  |  |  | 651 |

table 1

For the example showed in Figure 7,

For a simple toll plaza with the same number of B and L,

Therefore

Moreover, since is becoming large as B or L decrease, we can prove that the merge area in series type would have a larger capacity for any B and L (B>L). Thus, connecting two or more merge area in series is a practical and optimized scheme.

2) Parallel type

That is, divide the merge area transversely and put them together in parallel. Similarly, if we suppose B=8 and L=3 again, the toll plaza can be divided into two portions as Figure 8 shows.

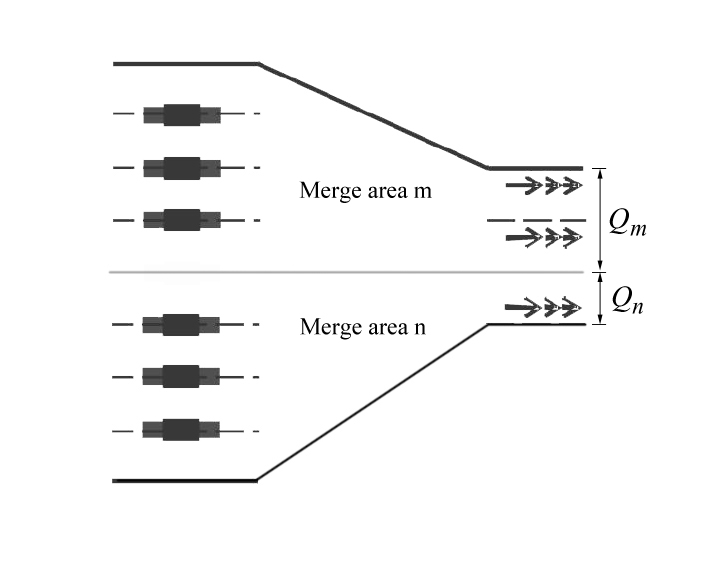


Figure 8 Parallel type

Since the two areas are juxtaposed,

, and respectively signify the maximal throughput of the merge area m, merge area n and the whole parallel-type toll plaza.

Similar to the analysis of the series type, is becoming large with the increasing of B or L. Thus, this solution could enlarge the maximal throughput efficaciously.

1. Conclusion

Based on the analysis above, both series type and parallel type can contribute to enlarging . Therefore, we can conclude confidently, both series type and parallel type are practical and effective methods to enlarge throughput.