Research of Diagonal Pedestrian Crossings at T-shaped intersections

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Backgrounds

The diagonal crossing, applied in many countries, is a pedestrian crossing system that stops all vehicular traffic and allows pedestrians to cross an intersection in every direction, including diagonally, at the same time.
Backgrounds

Setting conditions

Traffic signal lights have four green phases, four red phases

The intersection area is not very big

High pedestrian volume, and low vehicle volume

Question:
Can it be applied in the intersection of bigger area? Vehicles and pedestrian can pass at the same time?
The existing diagonal crosswalks (all-red phase) can we walk with vehicles? take a shortcut? left-turn vehicles, diagonal pedestrians can pass at the same time?
The intersection area is about 3500 m², belongs to a large intersection in Wuhan City.
Investigation and Analysis

T-shaped intersection

Illegal behaviors of diagonal pedestrian crossing

Illegal behaviors of diagonal crossing of bike riders
### Investigation and Analysis

**T-shaped intersection**

<table>
<thead>
<tr>
<th>Pedestrian volume of peak hour (p/h)</th>
<th>One-step crossing</th>
<th>Two-step crossing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jiefang Road section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>legal</td>
<td>850</td>
<td>659</td>
</tr>
<tr>
<td>illegal</td>
<td>104</td>
<td>758</td>
</tr>
<tr>
<td>Baofeng Road section</td>
<td>421</td>
<td></td>
</tr>
<tr>
<td>Diagonal direction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>legal</td>
<td></td>
<td>127</td>
</tr>
<tr>
<td>illegal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The demand of diagonal crossing is high, More than 50% pedestrians adopt one-step crossing without diagonal marked crosswalks, this is very dangerous.
# Investigation and Analysis

## T-shaped intersection

<table>
<thead>
<tr>
<th></th>
<th>Jiefang Road</th>
<th>Baofeng Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western entrance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left-turn straight</td>
<td>393</td>
<td>3921</td>
</tr>
<tr>
<td>Right-turn</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Eastern entrance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right-turn</td>
<td>-</td>
<td>2003</td>
</tr>
<tr>
<td>Left-turn straight</td>
<td>3488</td>
<td>1122</td>
</tr>
<tr>
<td>Right-turn</td>
<td></td>
<td>1051</td>
</tr>
</tbody>
</table>

The left-turn volume accounts for 52% of the total volume of Baofeng road entrance. This is a high rate.
Investigation and Analysis

Problem analysis

1. High pedestrian demand for diagonal crossing movement
2. High volume of left-turn vehicles
3. Low service level, frequent pedestrian-vehicle conflicts
Outline

1 Backgrounds
2 Investigation and Analysis
3 Improving Design
4 Discussion
5 Conclusion
T-shaped intersection

Improving Design

Before improvement

Arterial road

Minor road

After improvement

Arterial road

Minor road

High volume of left-turn vehicles → three marked crosswalks → High demand for diagonal crossing

Removes the crosswalk of low-rate utilization. (common method)
Improving Design

High volume of left-turn vehicles → Two crosswalks reserved in the intersection

Long green phase for left-turn vehicles → Long delay for pedestrians

Diagonal crosswalk → High demand for diagonal crossing

Illegal pedestrian behaviors “taking a shortcut”, “crossing red light"

The illegal behaviors of pedestrians crossing are unsafe, so the design of diagonal crosswalk at T-shaped intersections was put forward.
Improving Design

T-shaped intersection

- Diagonal crosswalks
- Serrated stop lines and left-turn waiting zone

Baofeng Road

Jiefang Road

Left-turn guide lines

Pedestrian Island

Z-shaped crosswalks
Improving Design

Pedestrian Islands in intersection

- Pedestrian island
- Crash barrier
- Ground markings

Dimensions:
- 4.6m
- 3m
- 0.2m
Improving Design

Similar signal phasing

Phase 1

Phase 2

Phase 3

Before improvement

After improvement
### Improving Design

#### Pedestrian delay

<table>
<thead>
<tr>
<th>Direction</th>
<th>One-step crossing</th>
<th>Two-step crossing</th>
<th>Pedestrian delay</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jiefang Road section</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before improvement</td>
<td>42</td>
<td>92</td>
<td>56</td>
</tr>
<tr>
<td>After improvement</td>
<td>41</td>
<td>92</td>
<td>56</td>
</tr>
<tr>
<td><strong>Baofeng Road section</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before improvement</td>
<td>20</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>After improvement</td>
<td>23</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td><strong>Diagonal direction</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before improvement</td>
<td>---</td>
<td>73</td>
<td><strong>73</strong></td>
</tr>
<tr>
<td>After improvement</td>
<td>44</td>
<td>70</td>
<td><strong>55</strong></td>
</tr>
</tbody>
</table>

After setting diagonal crossings, the delay of diagonal pedestrians crossing is reduced by 24.7%. The average delay for all pedestrians reduced by 13.2%.
Improving Design

Vehicle delay

- Reduce 26.9%
- Reduce 22.3%

Average vehicle delay reduces by 20.2%
Improving Design

Effective utilization rate of intersection area

Increase 25.7%
Increase 34.2%

Average utilization rate increases by 20.0%
Improving Design

Advantages

1) Shorten diagonal crossing distance
2) Reduce pedestrian delay
3) Reduce the number of conflicts
4) Increase effective utilization area
Improving Design

Improvement advantages

Shorten the walking distance of diagonal crossing, reduce the delay of vehicles and pedestrians (efficiency)

Reduce traffic conflict, reduce pedestrian violation rate (safety)

Less cost with easy construction
Outline

1 Backgrounds
2 Investigation and Analysis
3 Improving Design
4 Discussion
5 Conclusion
Mid-block crosswalks

Discussion

- Diagonal pedestrian crossing can shorten walking distance by 30%;
- Effective utilization area increases more than 110%.
- Being compatible with pedestrian’s “taking a shortcut” instinct.

The mid-block crossings

Diagonal crossings
## Discussion

### Applicable conditions

<table>
<thead>
<tr>
<th></th>
<th>Area (m²)</th>
<th>The rate of left-turn vehicles</th>
<th>The rate of illegal diagonal crossing</th>
<th>Speed (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-shaped intersection</td>
<td>2000-5000</td>
<td>&gt;45%</td>
<td>&gt;25%</td>
<td>&lt;40</td>
</tr>
<tr>
<td>Mid-block crossings</td>
<td>More than 6 lanes</td>
<td>&gt;20%</td>
<td>~</td>
<td>&lt;60</td>
</tr>
</tbody>
</table>
Discussion

- It is effective to all intersections (crossroad)?
Outline

1 Backgrounds
2 Investigation and Analysis
3 Improving Design
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5 Conclusion
## Conclusion

Diagonal crossings are effective for some of T-shaped intersections and mid-block crossings, and can improve the efficiency and safety of urban intersections.

<table>
<thead>
<tr>
<th>Question: The improvement can solve the problems of mixed traffic flow absolutely?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question: What is the applicable range (traffic composition, road conditions and pedestrian type) of the diagonal crossings?</td>
</tr>
</tbody>
</table>
Questions?

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