



# Analysis of Signalized Intersection Crashes

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# Outline

- ∅ An overview of signalized intersections and accidents
- ∅ Purpose of the study
- ∅ Methodology
- ∅ Crash prediction analysis
- ∅ Conclusion

# An overview of signalized intersections and accidents

- Signalized intersections are where most of the accidents happen because of the varying speeds, change of direction and many others.
- Among different factors considered for the cause of accidents at a signalized intersection like the AADT, speed, type of left turn control, pedestrian crossings etc., FHWA the most number of accidents at a signalized intersection are due to left turn .

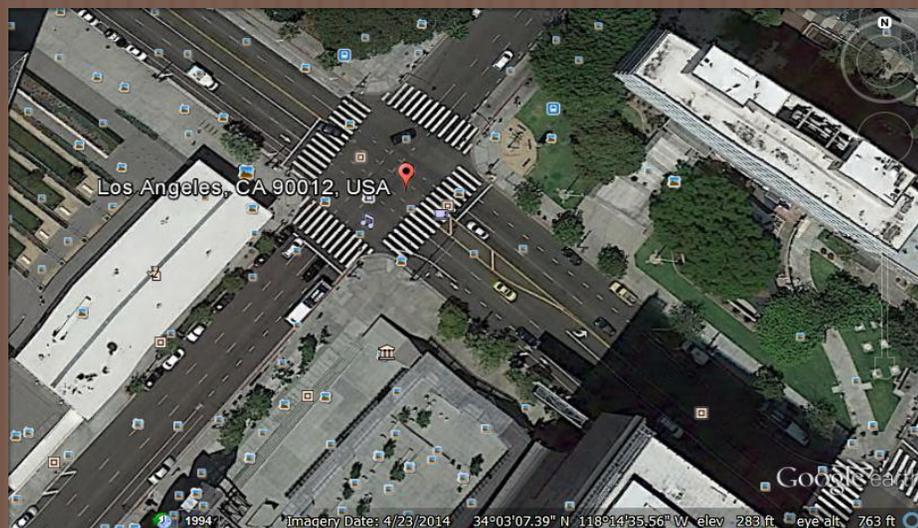
# General Pictures of Traffic Signals



(a) Protected/Permissive Mode (b) Protected Only

# Purpose of the study

- To weigh the various factors on a common scale and tell which could have more influence in a left turn collision.
- To set up the correlation of various factors on the left turning collisions.



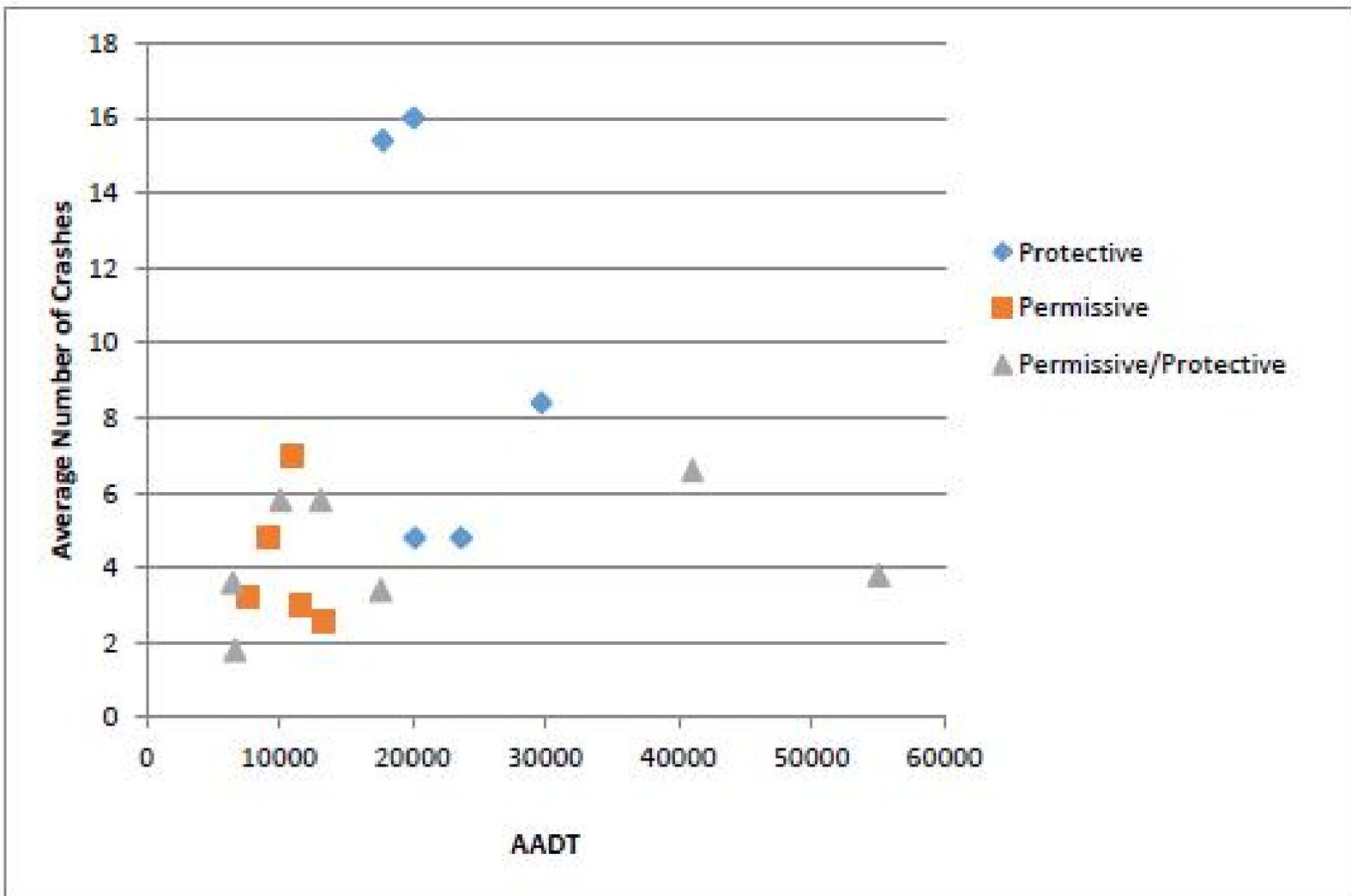
# Methodology

- Study has been conducted on 17 signalized intersections in the cities of Long Beach and Los Angeles in California.
- Data collected include AADT, number of accidents, speed range and other factors from the Public works of city.
- A linear regression model is developed to study the effect of various factors on the left turning accidents at these intersections.
- Finally, a detailed analysis is made to ultimately give some solutions for the left turning collisions and also some basis for future research so as to reduce the left turning collisions.

# Intersection information

| O Z | Intersecti<br>on        | Street Direction | Speed Limit (mph) | No. of Lane (EB) | No. of Lane (WB) | Intersecti<br>on      | Street Direction | Speed Limit (mph) | No. of Lane (NB) | No. of Lane (SB) | Type of Signal           |                          | AAD<br>T  | Averag<br>e<br>Accide<br>nts |
|-----|-------------------------|------------------|-------------------|------------------|------------------|-----------------------|------------------|-------------------|------------------|------------------|--------------------------|--------------------------|-----------|------------------------------|
|     |                         |                  |                   |                  |                  |                       |                  |                   |                  |                  | NB/SB                    | EB/WB                    |           |                              |
| 1   | 1 <sup>st</sup> St      | E/<br>W          | 30                | 3                | 3                | Main St               | N/<br>S          | 30                | 4                | -                | Protected                | -                        | 2367<br>1 | 4.8                          |
| 2   | 108 <sup>th</sup> St    | E/<br>W          | 30                | 2                | 2                | Main St               | N/<br>S          | 30                | 3                | 2                | Permissive               | Permissive               | 1159<br>6 | 3                            |
| 3   | 104 <sup>th</sup> St    | E/<br>W          | 30                | 1                | 1                | Main St               | N/<br>S          | 30                | 2                | 2                | Permissive               | Permissive               | 1331<br>0 | 2.6                          |
| 4   | Colden<br>Ave           | E/<br>W          | 30                | 1                | 1                | Main St               | N/<br>S          | 30                | 2                | 2                | Permissive               | Permissive               | 9142      | 4.8                          |
| 5   | 120 <sup>th</sup> St    | E/<br>W          | 30                | 2                | 2                | Main St               | N/<br>S          | 30                | 3                | 2                | Permissive               | Permissive               | 7631      | 3.2                          |
| 6   | Center Dr               | E/<br>W          | 35                | 4                | 4                | Sepulved<br>a Blvd    | N/<br>S          | 35                | 4                | 3                | Protected/permi<br>ssive | Protected                | 5504<br>9 | 3.8                          |
| 7   | Venice<br>Blvd          | E/<br>W          | 35                | 2                | 2                | Sepulved<br>a Blvd    | N/<br>S          | 35                | 4                | 4                | Protected/permi<br>ssive | Protected                | 4105<br>1 | 6.6                          |
| 8   | Westches<br>ter Pkwy    | E/<br>W          | 35                | 2                | 3                | Sepulved<br>a Blvd    | N/<br>S          | 35                | 3                | 3                | Protected/permi<br>ssive | Protected/permi<br>ssive | 1761<br>8 | 3.4                          |
| 9   | Bellflowe<br>r Blvd     | E/<br>W          | 40                | 4                | 4                | Atherton<br>St        | N/<br>S          | 40                | 3                | 3                | Protected                | Protected                | 2020<br>0 | 4.8                          |
| 10  | Palo<br>Verde<br>Ave    | E/<br>W          | 35                | 3                | 2                | Atherton<br>St        | N/<br>S          | 40                | 3                | 3                | Permissive               | Protected/permi<br>ssive | 1010<br>0 | 5.8                          |
| 11  | Anaheim<br>St           | E/<br>W          |                   | 3                | 3                | Long<br>Beach<br>Blvd | N/<br>S          |                   | 3                | 3                | Left turn<br>prohibited  | Protected                | 2010<br>0 | 16                           |
| 12  | Pacific<br>Coast<br>Hwy | E/<br>W          |                   | 3                | 3                | Long<br>Beach<br>Blvd | N/<br>S          |                   | 3                | 3                | Protected                | Protected                | 1780<br>0 | 15.4                         |
| 13  | Willow St               | E/<br>W          |                   | 3                | 3                | Long<br>Beach<br>Blvd | N/<br>S          |                   | 3                | 3                | Protected                | Protected                | 2970<br>0 | 8.4                          |
| 14  | 10 <sup>th</sup> St     | E/<br>W          |                   | 2                | 2                | Long<br>Beach<br>Blvd | N/<br>S          |                   | 2                | 2                | Permissive               | Protected                | 1090<br>0 | 7                            |
| 15  | 7 <sup>th</sup> St      | E/<br>W          |                   | -                | 3                | Long<br>Beach<br>Blvd | N/<br>S          |                   | 2                | 2                | Permissive               | Protected                | 1310<br>0 | 5.8                          |
| 16  | Hill St                 | E/<br>W          |                   | 2                | 2                | Long<br>Beach<br>Blvd | N/<br>S          |                   | 2                | 2                | Permissive               | Protected                | 6500      | 3.6                          |
| 17  | Burnett St              | E/<br>W          |                   | 2                | 2                | Long<br>Beach<br>Blvd | N/<br>S          |                   | 3                | 3                | Permissive               | Protected                | 6700      | 1.8                          |

# AADT vs. Average Number of Intersection Crashes



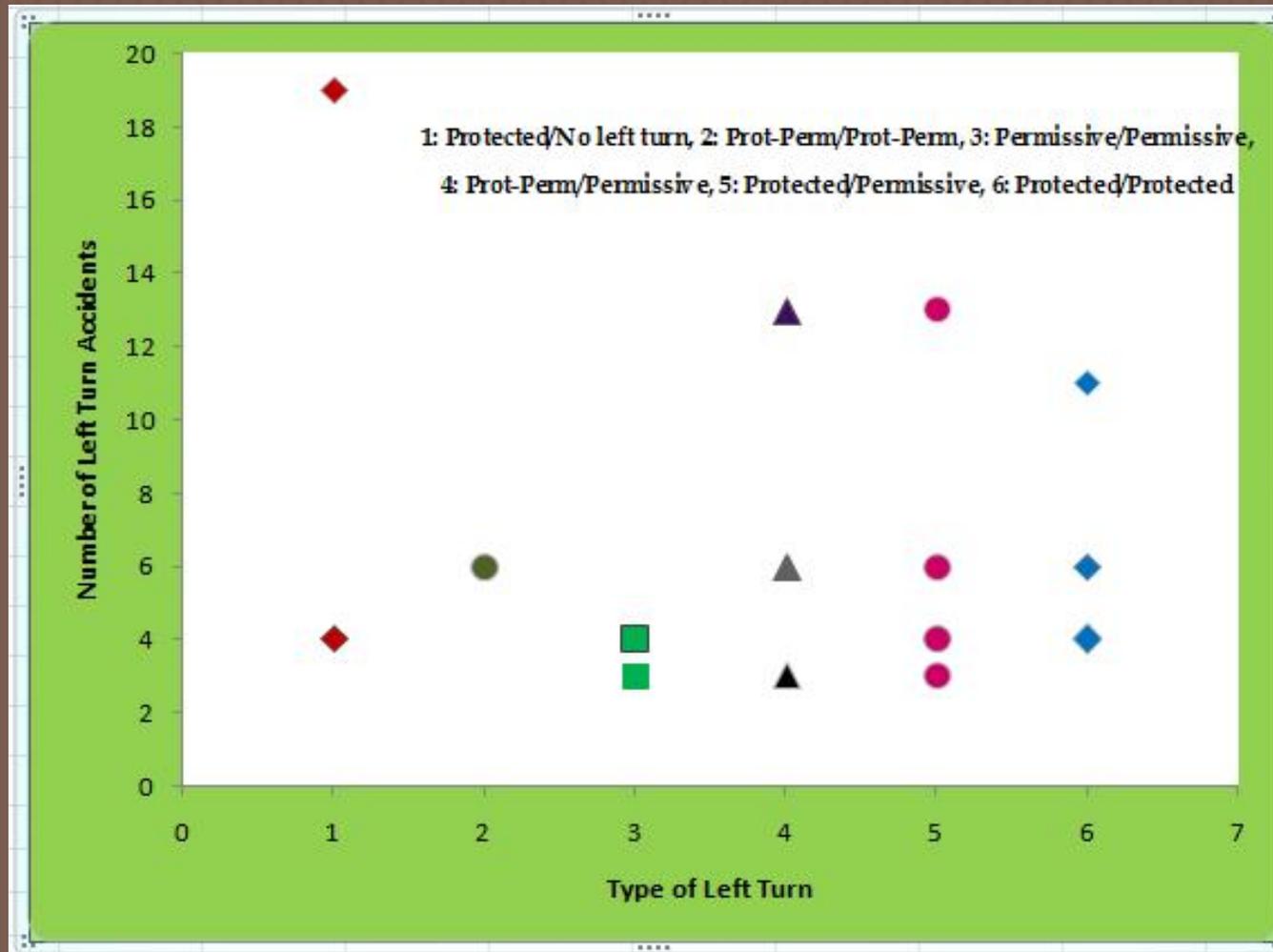
# Linear Regression of Average Number of Accidents with AADT

| Regression Model           | Values   |
|----------------------------|----------|
| R                          | 0.138158 |
| R Square                   | 0.019088 |
| Std. Error of the Estimate | 4.148667 |
| Coefficient of Regression  | 5.135814 |
| p-value                    | 0.011346 |

# Total left turn related accidents only with the types of signal

| Intersection                         | Type of Signal         | Total Left Turn Accident |
|--------------------------------------|------------------------|--------------------------|
| 1 <sup>st</sup> St-Main St           | Protected/No Left Turn | 4                        |
| 108th St-Main St                     | Permissive/Permissive  | 3                        |
| 104th St-Main St                     | Permissive/Permissive  | 3                        |
| Colden Ave-Main St                   | Permissive/Permissive  | 4                        |
| 120 <sup>th</sup> St- Main St        | Permissive/Permissive  | 3                        |
| Center Dr- Sepulveda Blvd            | Prot-Perm/Permissive   | 3                        |
| Venice Blvd- Sepulveda Blvd          | Prot-Perm/Permissive   | 6                        |
| Westchester Pkwy- Sepulveda Blvd     | Prot-Perm/Prot-Perm    | 6                        |
| Bellflower Blvd- Atherton St         | Protected/Protected    | 6                        |
| Palo Verde Ave-Atherton St           | Prot-Perm/Perm         | 13                       |
| Anaheim St- Long Beach Blvd          | Protected/No Left Turn | 19                       |
| Pacific Coast Hwy- Long Beach Blvd   | Protected/Protected    | 11                       |
| Willow St- Long Beach Blvd           | Protected/Protected    | 4                        |
| 10 <sup>th</sup> St- Long Beach Blvd | Permissive/Protected   | 13                       |
| 7 <sup>th</sup> St- Long Beach Blvd  | Permissive/Protected   | 6                        |
| Hill St-Long Beach Blvd              | Permissive/Protected   | 4                        |
| Burnett St- Long Beach Blvd          | Permissive/Protected   | 3                        |

# Intersections with Left turn accidents only Vs Types of left turn



# Linear Regression of Average Number of Accidents

| Variables | Linear Regression Coefficients | p-value  | R Square | Std. Error of the Estimate |
|-----------|--------------------------------|----------|----------|----------------------------|
| AADT      | 1.515                          | 0.469121 |          |                            |
| LANE      | -4.64                          | 0.071    |          |                            |
| MEDN      | 1.573                          | 0.13181  | 0.65675  | 3                          |
| PEDN      | -2.51                          | 0.37954  |          |                            |
| LT SIGNAL | 6.572                          | 0.02837  |          |                            |
| SPEED     | 0.3425                         | 0.1742   |          |                            |

# Crash Prediction Analysis

q A regression analysis is performed using the average accident data for five years.

q Independent variables used are AADT, travel speed, average number of lanes, presence of medians, pedestrian crossings, types of left turn control.

q By introducing dummy variable where 0 represents protected control and 1 represents permissive or combination of protective-permissive control, the type of left turn signal control is evaluated.

# Crash Prediction Analysis (Cont.)

The resulting relationship is as follows:

$$\text{Acc} = 1.52 \ln (\text{AADT}) - 4.64L + 1.57\text{MDN} - 2.51\text{PED} + 6.57\text{LT SGNAL} + 0.34\text{SPD} - 5.81$$

Where,

Acc= average number of crashes;

AADT=annual average daily traffic;

L=total number of lanes at the intersection;

MDN=total number of medians at the intersection;

PED= total number of pedestrians at the intersection;

LT SGNAL=type of left turn signal control;

SPD= travel speed

# Conclusion

- q Due to a very small sample size of 17 intersections from two different cities, some limitations are observed .
- q Data on each road changes were collected for five to six years.
- q Performing regression analysis at 10% significance level brought some correlation between the AADT and average no of accidents.



# Conclusion (cont.)

- The analysis shows that traffic accidents and those factors (variables) have a relationship that could be useful for traffic engineers and the planners.
- Further studies may be needed to suggest different types of signals at the intersections.

# Acknowledgements

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- Public Works from the cities of Long Beach and Los Angeles for their cooperation to collect all traffic data