

# Security in Crosswalks

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**Abstract**—Lighting is not only important for the safety of traffic, but also it is very important for the protection of pedestrians. Improvement on visibility in a long distance, lighting, signing, reduces considerably the risk of accidents in crosswalks. This paper evaluates different aspects of crosswalks including signing and lighting to improve road safety.

**Keywords**—In pavement flashing warning lights, street lighting, signing, visibility.

## I. INTRODUCTION

PEDESTRIAN safety is among one of the largest concerns in the transportation industry, because of its high mortality rate, such as one of the new developments in this regard, it is the new system of security which it include airbag for pedestrians, as shown in the following image.



Fig. 1 Airbag for pedestrians [1]

Although these vehicles provide more safety for pedestrians, through a series of improvements in crosswalks, it could achieve the same results, as it is shown below.

## II. ACCIDENTS OF PEDESTRIANS

According to the National Highway Traffic Safety Administration (NHTSA) [2], in 2006, data of 4784 pedestrians were killed and 61,000 injured, these data are very high, for better visualization, a table is shown with the results.

TABLE I  
NUMBER OF ACCIDENTS IN 2006 [2]

Age (Years)	Location		Total
	Intersection	Nonintersection	
	Number	Number	Number
<b>Pedestrians Killed</b>			
< 5	19	89	108
5 - 9	23	80	104
10 - 15	45	109	157
16 - 20	36	234	274
21 - 24	44	239	290
25 - 34	97	510	615
35 - 44	126	637	770
45 - 54	189	728	933
55 - 64	130	429	567
65 - 74	119	253	374
> 74	173	347	530
Unknown	7	49	62
<b>Total</b>	<b>1008</b>	<b>3704</b>	<b>* 4784</b>
<b>Pedestrians Injured</b>			
< 5	***	1000	2000
5 - 9	2000	2000	4000
10 - 15	5000	4000	9000
16 - 20	3000	3000	7000
21 - 24	2000	2000	3000
25 - 34	4000	4000	8000
35 - 44	4000	4000	9000
45 - 54	3000	4000	7000
55 - 64	4000	2000	6000
65 - 74	2000	1000	3000
> 74	2000	1000	3000
<b>Total</b>	<b>30000</b>	<b>29000</b>	<b>** 61000</b>
* Includes 72 pedestrians killed at other or unknown locations.			
** Included 2000 pedestrians injured at other or unknown locations.			
*** Less than 500			

If we represent the number of accidents in terms of hours it could be seen that the contribution of natural light affects the visibility and response time of drivers.

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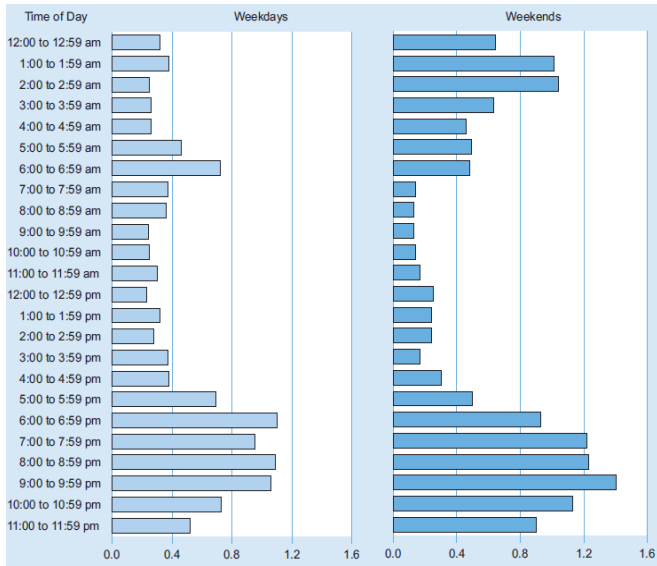


Fig. 2 Number of accidents distributed in hours [2]

In this graphic we can conclude that the light level is directly related to the visibility, and therefore it affects the response time.

Pedestrians often assume that drivers can see them clearly at night, however, drivers often don't see pedestrians at night until pedestrians are within the safe stopping distance.

### III. SPEED AFFECTS CRASH AVOIDANCE

Speeding is one of the factors that contribute to such accidents. In 1997, according to FHWA-RD-01-02 [3] speeding contributed to 30% of all accidents.

Speeding is fatal when a pedestrian is involved:

- If you run over 64.4 kmh has an 85% chance of dying.
- At 48.3 kmh, the probability drops to 45%
- While at 32.2 kmh, the mortality rate is only 5%.

Thus at higher speeds, the drivers are more likely not to see pedestrians and reduces the ability of the drivers to avoid impact [4].

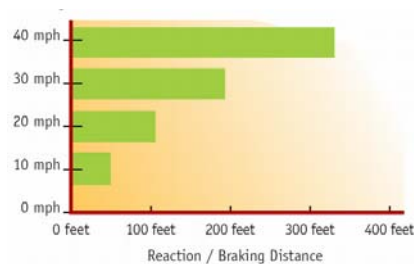


Fig. 3 Breaking distance [4]

It is indispensable to encourage speed hump for crosswalks because it is a useful tool to reduce the number of deaths due it causes a reduction in the speed of vehicles.

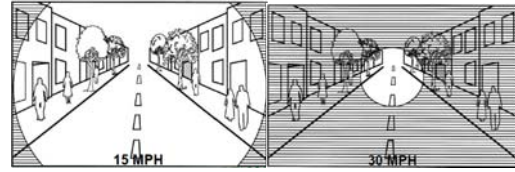


Fig. 4 As speed increases, driver focuses less on surroundings [4]

### IV. SIGNAGE OF RAISED CROSSWALKS

Visibility is another aspect to consider; therefore raised crosswalks should have both horizontal and vertical signage.

Road markings is regulated in Spain by Standard 8.2-IC [5], using transverse white bands located on the upper level of 50 cm width and spacing, and it should include white bands of 40 cm width transverse to one meter the beginning of the ramp, then it presents an image.

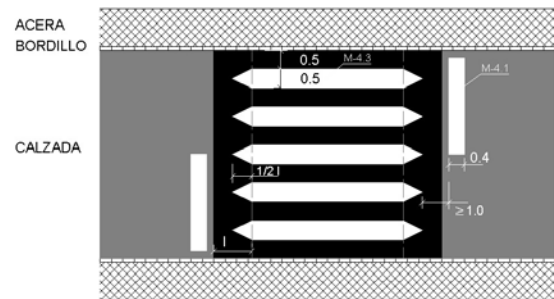


Fig. 5 Horizontal signage in raised crosswalks [5]

Vertical signage includes three types of signals, speed limit, the shoulder and the proximity, these signals must be arranged in the same order than the direction of traffic.

Although in reality it is not very common, these devices must have night lighting, in order to ensure its visibility, location and presence of pedestrians.

But when there are multiple lanes in the same direction of traffic it is advisable to advance the stop line to reduce multiple-threat crashes as it is shown in the following figures.

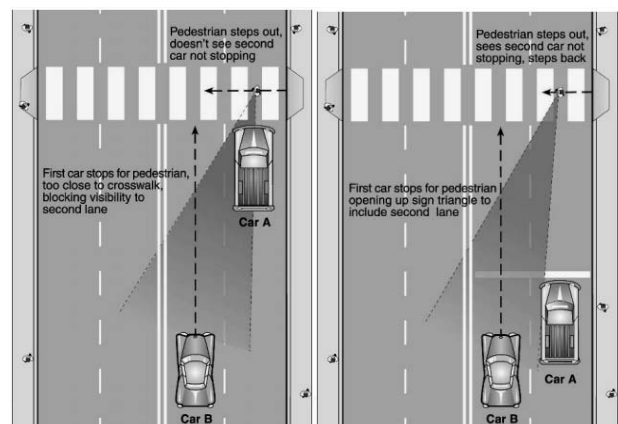


Fig. 6 Multiple threat crash problem [4]

The separation distance between the crosswalk and the stop line should be at least 6 meters [6].

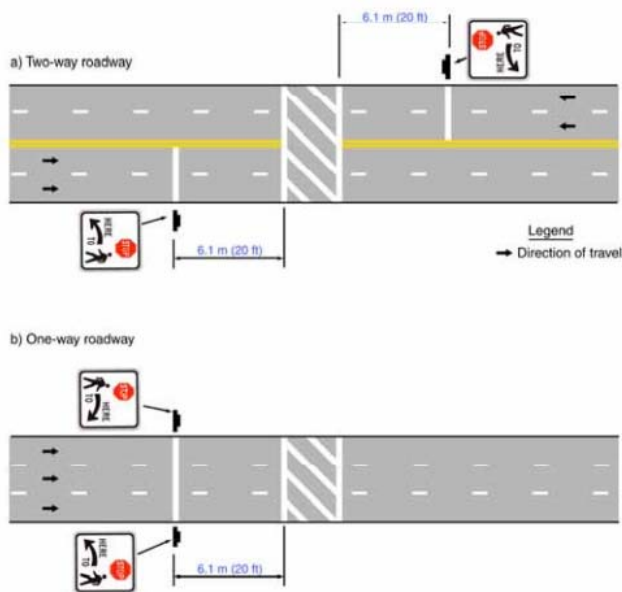


Fig. 7 Distance between crosswalks and stop line [6]

#### V. ILLUMINATION LEVELS

The lighting reduces the likelihood of death in pedestrians [4] by 54%, but it depends on the rules from the country to establish the levels. The next points show some regulations to illuminate pedestrian crossings.

##### A. Decree 1890/2008

In lighting of crosswalks, the minimum level of vertical illuminance is 40 lux. The class will be CE1 in commercial and industrial areas and residential areas CE2 [7].

TABLE III  
HORIZONTAL ILLUMINANCE [7]

CE class	Horizontal Illuminance
	Em (lux)
CE1	30
CE2	20

##### B. CIE

CIE [8] has not given a recommend light level value for crosswalk lighting, but it has specified light levels for pedestrian areas. The CIE divides the road into several classes by the magnitude of pedestrian flow and specifies a recommended light level for each case.

TABLE IV  
RECOMMENDED ILLUMINANCES FOR DIFFERENT ROAD TYPES IN PEDESTRIAN AREAS [8]

Description of road	Horizontal Illuminance	
	Average (lux)	Minimum (lux)
High prestige road	20	7,5
Heavy nighttime use by pedestrians	10	3
Moderate nighttime use by bicyclists	7,5	1,5
Minor nighttime use by pedestrians solely associated with adjacent properties	5	1
Minor nighttime use by pedestrians solely associated with adjacent properties; important to preserve village or architectural character of environment	3	0,6
Very minor nighttime use by pedestrians solely associated with adjacent properties; important to preserve village or architectural character of environment	1,5	0,2

#### VI. IN-PAVEMENT FLASHING WARNING LIGHTS

Lately it is performing an installation type other than what we are accustomed.

This system consists of installing the lights embedded in the pavement along both sides of the crosswalk. When a pedestrian light activated by a presence detector or by pressing the button, the operation enters flashing lights during a period of time to warn the driver of the presence of a pedestrian. The beauty of this system is its high efficiency because after a certain time the lights go out, help reduce unnecessary consumption.



Fig. 8 In-pavement flashing warning lights [9]

This system has been approved by the Federal Highway Administration (FHWA) Manual on Traffic Control Devices (MUTCD), establishing the design features, such as the speed of the flash will be at least 50 beats per minute, but not more than 60.

#### VII. CONCLUSION

New systems are being implemented to improve both safety and to increase the energy efficiency of lighting installations with good results, one example it is installed in Denville, New Jersey [8], with good outcomes:

- 1) Improves the visibility of pedestrians to drivers.
- 2) Reducing the average speed of vehicles approaching the crosswalk.
- 3) Reducing the number of vehicles passing over the crosswalk while a pedestrian is waiting

We want to show some pictures of the installation to appreciate all the above.



Fig. 9 In-pavement flashing warning lights in Denville [9]

It is still early to give details on the reduction in the number of accidents but it is able to reduce the speed of vehicles so we are sure that it will reduce the number of road deaths.

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