Characteristics of Intersection Accidents in Rural Municipalities

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Engineering guidelines for traffic and safety improvements have developed from studies conducted primarily in urban areas where traffic engineering expertise is available. This paper summarizes applicable data collected in several comprehensive studies of small city and town intersections. Conclusions are drawn concerning those areas in which urban and rural accident patterns and roadway conditions are both similar and different and concerning how the difference may affect traffic engineering decision making for rural areas.

STUDY AREA

More than 300 intersections in 42 towns and cities in Virginia were included in two studies funded by the Virginia Division of Highway Safety. Initial data collection funding was from U.S. Department of Transportation Highway Safety funds. Of the total number of intersections studied, 232 rural intersections are reviewed in this paper. The typical rural municipality has an average population of approximately 15 000. Accident data are based on state records obtained from the municipalities, which must report all accidents causing at least $100 damage. More than 2300 accidents are summarized by intersection for a 24-month period between 1969 and 1973.

If there are differences in accident characteristics between rural and urban areas, there logically should be differences in driver behavior or roadway conditions to cause these differences. In rural areas, drivers may be less aggressive because of less traffic congestion, a higher percentage of local drivers familiar with the intersections, and drivers not conditioned to extensive repetition and enforcement of standard roadway design and traffic operation.

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ACCIDENT TYPES VERSUS INTERSECTION TRAFFIC CONTROL

A summary of all intersection accidents studied by accident type and intersection traffic control is given in Table 1. Rear-end collisions and angle collisions compose 36 and 43 percent of total accident types respectively. The percentage for angle collisions is low compared to that found in some other studies, which indicated that angle accidents constituted as much as 83 percent (1) of the total. The intersections with STOP and YIELD sign control have a higher percentage of angle and lower percentage of rear-end collisions than the signalized intersections, which is consistent with other studies (2).

ACCIDENT TYPES VERSUS INTERSECTION GEOMETRICS

A summary of accidents by intersection geometrics and type of traffic control is given in Table 2. Whereas Y-type and offset intersections have accident patterns characteristic of the summary totals in Table 1, there are some interesting facts in four-way and T-type intersection patterns. Previous studies indicate that four-way intersections have up to four times the number of accidents as T-types of intersections (3). Although the four-way intersection accident rate of 1.35 is higher than the 0.80 for T-types, this is only a 69 percent increase.

Signalized four-way and T-types of intersections have higher percentages of rear-end collisions than intersections controlled by STOP and YIELD signs (40 and 58 percent versus 22 and 28 percent respectively). On the other hand, four-way and T-types of intersections with STOP and YIELD sign control have a higher percentage of angle collisions than do signalized intersections (59 and 43 percent versus 40 and 29 percent respectively). This reconfirms general knowledge that signalization of an intersection tends to reduce angle collisions but increase rear-end collisions.

SIGNALIZED INTERSECTIONS

A summary of accidents at signalized intersections conforming with the minimum signal display criteria of the 1971 Manual on Uniform Traffic Control Devices—two indications per approach and one head within the 40-deg cone of vision—is given in Table 3. Also identified are those signalized intersections that meet the minimum traffic volume warrants of the manual. The most important fact is that the accident rate for all four categories is nearly identical. Whether or not a traffic signal control meets the volume warrants or standard display criteria appears to have no bearing on accident frequency. Even the breakdown by accident type is fairly consistent for all four categories despite the small sample size for two categories. These findings are inconsistent with other studies that indicate that signalized intersections with lower traffic volumes (4, chap. 4) and substandard signal display (5) tend to have higher accident rates.

It is interesting to note that both warranted and unwarranted signalized intersections with substandard displays have a higher percentage of angle collisions (48 and 46 percent) than the standard display intersections (40 and 35 percent). The occurrence of fewer angle collisions at standard display intersections is consistent with a previous study (5).

TRAFFIC VOLUMES

A comparison of accident rates under STOP or YIELD sign control versus traffic signal control was made for various intersection types and average daily traffic (ADT) volumes (Table 4). For a given intersection and ADT, signalized intersections have a higher accident rate than those intersections with STOP or YIELD sign

Table 1. Summary of accidents.

Intersection		Rear End		Angle		Sideswipe		Other[a]			Average Accident
Type	Number	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Total	Rate[b]
Signalized	76	508	43	445	37	142	12	100	8	1195	1.26
STOP or YIELD sign control[c]	156	316	29	542	49	110	10	138	12	1106	1.08
Total	232	824	36	987	43	252	11	238	10	2301	1.13

[a]Includes mostly head-on and fixed-object collisions. [b]Accidents per million entering vehicles. [c]Includes STOP sign control with flashing beacons.

Table 2. Accidents by intersection geometrics.

Intersection		Rear End		Angle		Sideswipe		Other			Average Accident
Type[b]	Number	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Total	Rate[a]
Four-way											
Signalized	52	379	40	384	40	105	11	79	9	947	1.47
STOP or YIELD sign control	66	125	22	340	59	55	10	50	9	570	1.27
Total	118	504	33	724	48	160	11	129	8	1517	1.35
T-type											
Signalized	12	68	58	30	25	13	11	7	6	118	0.82
STOP or YIELD sign control	48	72	28	109	43	30	12	44	17	255	0.79
Total	60	140	38	139	37	43	11	51	14	373	0.80
Offset											
Signalized	3	3	42	0	0	2	29	2	29	7	0.40
STOP or YIELD sign control	9	16	34	14	30	6	13	11	23	47	0.76
Total	12	19	35	14	26	8	15	13	24	54	0.58
Y-type											
Signalized	1	10	42	7	29	6	25	1	4	24	1.40
STOP or YIELD sign control	14	68	66	24	23	4	4	7	7	103	1.04
Total	15	78	61	31	25	10	8	8	6	127	1.22

[a]Accidents per million entering vehicles. [b]Accidents for miscellaneous intersection geometrics not summarized.

Table 3. Accidents by signalized intersections.

Intersection		Rear End		Angle		Sideswipe		Other			Average Accident
Characteristics	Number	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Total	Rate[a]
Meets warrants											
Standard display	50	390	45	306	35	107	12	69	8	872	1.26
Substandard display	5	32	36	41	46	8	9	9	9	90	1.28
Below warrants											
Standard display	14	67	38	70	40	25	14	13	8	175	1.26
Substandard display	7	19	33	28	48	2	3	9	16	58	1.23

[a]Accidents per million entering vehicles.

control. This is true for all four traffic volume categories despite significant variations in sample size for each category. The signalized intersections, in fact. have a 29 percent higher accident rate. This strongly suggests, as do other studies (6), that a typical signalized intersection will have a higher accident frequency than one with STOP or YIELD sign control.

SEVERE GRADES, POOR SIGHT DISTANCE, AND NIGHT VERSUS DAY

Accident data for intersections that provide poor driver sight distance on at least one traffic approach or that have an unusually steep grade are given in Table 5. (Poor sight distance is based on factors such as vehicle speed and degree of sight obstruction as well as sight distance. Severe grades are usually greater than 5 percent.) The accident rate of 0.97 for intersections with severe grades is unusually low in light of the high accident potential such roadway conditions possess and when compared to the accident rate of 1.13 for all intersections. During the study of the intersections, it was observed that intersections with extremely severe grades, such as many of those in the small municipalities in the Shenandoah and Blue Ridge mountains, experience unusually low accident rates. It appears that drivers are aware of the dangerous roadway conditions and exercise due caution.

Intersections with poor sight distance have a relatively high accident rate of 1.33. As would be expected, 56 percent of the accidents were angle collisions in which the driver was unable to properly view an approaching vehicle on the cross street.

Of the total accidents, 30 percent occurred at night with less than 3 percent variance from this amount for any traffic pattern or roadway geometry category. This strongly suggests that traffic and physical roadway conditions have no relationship to frequency of night accidents.

CONCLUSIONS AND RECOMMENDATIONS

Driver behavior and roadway conditions in rural municipalities differ from those in urbanized areas. However, the following conclusions concerning rural accident characteristics reconfirm results of previous studies.

1. A typical intersection with a given volume of traffic will have a higher accident frequency under traffic signal control than under STOP or YIELD sign control. Prior to the costly installation of traffic signal control, a thorough engineering analysis must be performed to clearly identify and quantify the benefits of signalization.
2. Intersections with poor driver sight distance on one or more traffic approaches tend to have a higher-than-normal accident rate, particularly with regard to angle collisions. Increasing driver sight distance will likely effect a reduction in this type of collision.
3. Standardizing signal display should result in reduced accidents at locations with a relatively high number of angle collisions.
4. The frequency of night accidents appears to be totally unrelated to traffic patterns, traffic control, or intersection geometrics. Although it was not determined from the data, adequacy of proper night lighting appears to be the controlling factor in this environment. At intersections where more than one-third of the accidents occur at night, the adequacy of street lighting should be determined.

Some unique conclusions, which seem to apply only to rural municipalities, can be drawn from the accident data.

1. Intersections with severe grades generally operate safely although they are obviously potential hazards. Accident histories should be closely studied before substantial funds are invested to alleviate a severe grade condition.
2. Signalized intersections with volumes exceeding the traffic volume warrants are no safer than signalized intersections with volumes below the warrants. This can possibly be explained by differences between rural and urban driver characteristics. The need to implement a policy of eliminating unwarranted signals in rural areas is perhaps not so urgent as in urban areas.
3. Signalized intersections with displays that meet approved standards are no safer than signalized intersections with substandard displays. Again, differences between rural and urban driver characteristics and physical surroundings could explain this discrepancy.

Although traffic engineers in rural jurisdictions should certainly continue to upgrade substandard signal displays, the need to implement this policy is perhaps not so urgent from a safety standpoint as it is with the urban counterpart.

Whether or not traffic control measures are to be implemented in an urban or rural area, sound traffic engineering analysis and judgment must be followed. To provide effective rural policy, the traffic engineer requires a knowledge of the particular conditions of the given study area and an awareness of the general findings of this paper.

Table 4. Average accident rate by intersection ADT.

ADT	Traffic Control	Number of Intersections	Average Accident Rate[a]
<10 000	Sign	93	1.12
	Signal	15	1.33
10 000 to 15 000	Sign	47	1.05
	Signal	35	1.26
15 000 to 20 000	Sign	11	0.97
	Signal	12	1.09
>20 000	Sign	5	0.52
	Signal	14	1.26

[a]Accidents per million entering vehicles.

Table 5. Accidents at intersections with severe grades and poor sight distance.

Intersection		Rear End		Angle		Sideswipe		Other			Average
Condition	Number	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Total	Accident Rate[a]
Severe grades	35	106	39	104	38	24	9	37	14	271	0.97
Poor sight distance	41	73	20	207	56	32	9	54	15	366	1.33

[a]Accidents per million entering vehicles.

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