

# Effect of Shoulder Width on Accidents on Two-Lane Tangents

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California accident records for 1948 were examined for the relation between shoulder width and accident occurrence on two-lane tangents. For similar traffic volumes, shoulders 6 feet wide were safer than narrower shoulders and, also, (at volumes over 5,000 vehicles per day) safer than wider shoulders.

● THE purpose of this study was to examine the relation between highway shoulder widths and accident occurrence on two-lane tangents. The California Division of Highways made the study possible by providing, for two-lane roads of the California Interstate Highway System, the number of accidents reported for 1948, the corresponding shoulder and lane widths, and estimates of traffic volume.

The data used were for rural road sections, with 55-mph. speed limit, of bituminous or concrete pavement, without structures or intersections (except private driveways), and predominantly straight and level. Some curves are included, but sections containing many or severe curves have been eliminated. The study is limited to paved or treated shoulders, some being of concrete but the large majority bituminous. It is believed that in all cases the shoulders were visually distinguishable from the roadway proper. Included are 533 miles of road, on which 1,333 accidents were reported for 1948.

The road sections were grouped by traffic volume and shoulder width as shown in the Table. (Groups with a mileage of less than a mile have been omitted.) From the 46 points listed, the following regression equations<sup>1</sup> were obtained:

$$\sqrt{A} = .4766 + .02202 \sqrt{vm} \quad (1)$$

$$\sqrt{A} = -.0567 + .02287 \sqrt{vm} + .3175 \sqrt{m} \quad (2)$$

(if  $S < 6'$ )

$$\sqrt{A} = .1018 + .01971 \sqrt{vm} + .4514 \sqrt{m} \quad (3)$$

(if  $S < 6'$ ) + .005485  $\sqrt{vm}$  (if  $S > 6'$ , and  $v > 5000$ )

Where A = number of accidents  
 v = average daily traffic volume  
 m = length of the road section  
 S = shoulder width

Values of  $\sqrt{A}$  given by Equation 1, which does not give effect to shoulder width, and by Equation 3, which does, are shown in Table 1 for comparison with the observed values of  $\sqrt{A}$ .

For Equations 1, 2, and 3, the values of the correlation index  $R^2$  are 0.824, 0.856, and 0.900 respectively. The difference in the first two values shows a significant<sup>2</sup> tendency, in the data analyzed, for accident rates to be lower on roads having shoulders of 6 feet or more than on roads with narrower shoulders. The difference in the last two values shows that, for traffic of over 5,000 vehicles per day, accident rates were significantly lower with 6-foot shoulders than with wider shoulders.

The analysis considers only three shoulder widths: less than 6 feet, 6 feet, and more than 6 feet. (Preliminary investigation indicated that the data are too erratic to permit study of finer distinctions in width). It should be emphasized that the comparison is between 6-foot shoulders and the entire group of widths below, or above 6 feet. It cannot be directly deduced that the 6-foot shoulders were safer than 5-foot or 7-foot shoulders.

Figure 1 shows the observed relation between accident rates and the three categories of shoulder width, consolidating the data of Table 1. The corresponding values given by Equation 3 are shown in Figure 2. A warning may be useful: Even if the

<sup>1</sup>The square root of the number of accidents was chosen as the dependent variable because of its nearly constant variance, very desirable in regression analysis.

<sup>2</sup>The F test shows that the difference in  $R^2$  is significant at the 0.01-level for Equations 1 and 2 and at the 0.001-level for Equations 2 and 3.

theoretical relations are fundamentally sound, the values found for the constants in the equations are subject to error because of the large difference between reported and actual accident rates.

It may be seen in Figure 1 that for comparable traffic volumes, accident rates for 6-foot shoulders were (1) uniformly lower than for narrower shoulders and (2) at volumes over 5,000 vehicles per day, lower than for wider shoulders.

Preliminary investigation indicated that the data would not yield an effect of lane width on accidents. Table 1 indicates lane widths (showing pavement widths as rounded averages per mile), and a glance at the column may suffice

to show that the effects attributed to shoulder width are not due to differences in lane width.

It is easy to find reasons why shoulders of about 6 feet should be safer than narrower shoulders. Very narrow shoulders may induce drivers to keep away from the pavement edge (2) reducing clearance between passing vehicles. Narrow shoulders certainly restrict emergency maneuverability. Shoulders narrower than about 6 feet may prevent parking off the roadway. But these reasons do not imply much gain in shoulders wider than about 6 feet. It is true that trucks may need as much as 8 feet for parking, and that additional width may be useful in working on a disabled vehicle. But shoulders wider than

TABLE 1  
ACCIDENT DATA GROUPED BY TRAFFIC VOLUME AND SHOULDER WIDTH

Average Daily Traffic	Shoulder Width ft.	Average Pavement Width	No of Accidents	Miles	Accidents Per Mile	$\sqrt{A}$	$\sqrt{A}$ from Equation 1	$\sqrt{A}$ from Equation 3
v	S	L	A	m	A/m	$\sqrt{A}$		
500-900	8	24	1	5.7	2	1.0	1.9	1.3
1,000-1,400	2	22	3	4.0	.7	1.7	2.0	2.4
	10	20	1	3.2	.3	1.0	1.8	1.3
	11	22	2	7.5	.3	1.4	2.6	2.0
1,500-1,900	2	21	7	6.1	1.1	2.6	2.7	3.2
	3	21	44	22.3	2.0	6.6	4.8	6.1
	4	22	7	3.0	2.3	2.6	2.0	2.3
	5	20	22	10.7	2.0	4.7	3.4	4.3
	8	22	50	68.4	.7	7.1	8.0	6.8
2,000-2,900	3	20	49	12.6	3.9	7.0	4.2	5.0
	4	20	7	5.7	1.2	2.6	2.9	3.4
	5	22	22	14.2	1.6	4.7	4.4	5.3
	6	21	10	14.7	.7	3.2	4.6	3.8
	7	20	3	1.1	2.6	1.7	1.6	1.1
	8	24	25	56.8	.4	5.0	8.3	7.1
3,000-3,900	4	22	21	13.5	1.6	4.6	5.2	6.0
	5	27	14	6.5	2.2	3.7	3.9	4.3
	6	20	39	26.8	1.5	6.2	7.0	6.0
	8	21	49	34.6	1.4	7.0	8.0	6.8
4,000-4,900	4	28	14	4.9	2.9	3.7	3.6	3.9
	5	16	11	2.7	4.0	3.3	3.0	3.1
	6	23	35	11.1	3.1	5.9	5.3	4.4
	7	21	2	1.2	1.6	1.4	2.1	1.5
5,000-6,400	8	20	52	24.3	2.1	7.2	7.8	6.7
	3	20	41	8.6	4.8	6.4	5.6	6.0
	6	36	26	9.5	2.7	5.1	5.4	4.5
	7	20	36	9.4	3.8	6.0	5.7	6.0
6,500-7,900	8	21	84	20.9	4.0	9.2	8.1	8.8
	2	20	12	1.0	12.0	3.5	2.3	2.2
	3	18	51	9.5	5.4	7.1	6.3	6.7
	4	21	15	3.5	4.2	3.9	4.1	4.2
	5	22	15	2.6	5.8	3.9	3.6	3.6
	7	22	57	8.4	6.8	7.5	6.0	6.4
8,000-9,400	8	20	64	17.5	3.7	8.0	8.3	9.0
	10	20	9	1.5	6.0	3.0	2.8	2.7
	2	20	35	5.5	6.4	5.9	5.3	5.5
	3	19	53	9.9	5.3	7.3	6.9	7.2
	4	20	10	3.6	2.8	3.2	4.3	4.3
	6	20	35	7.9	4.5	5.9	6.2	5.2
9,500-10,900	8	20	110	22.7	4.8	10.5	10.1	11.1
	9	20	9	3.4	2.6	3.0	4.2	4.3
	10	20	15	1.7	8.6	3.9	3.2	3.2
	8	20	138	18.2	7.6	11.7	9.9	10.9
	2	20	8	1.1	7.1	2.8	2.9	2.8
11,000-12,400	6	20	12	3.2	3.8	3.5	4.8	4.0
	10	20	8	1.1	7.5	2.8	3.0	3.0

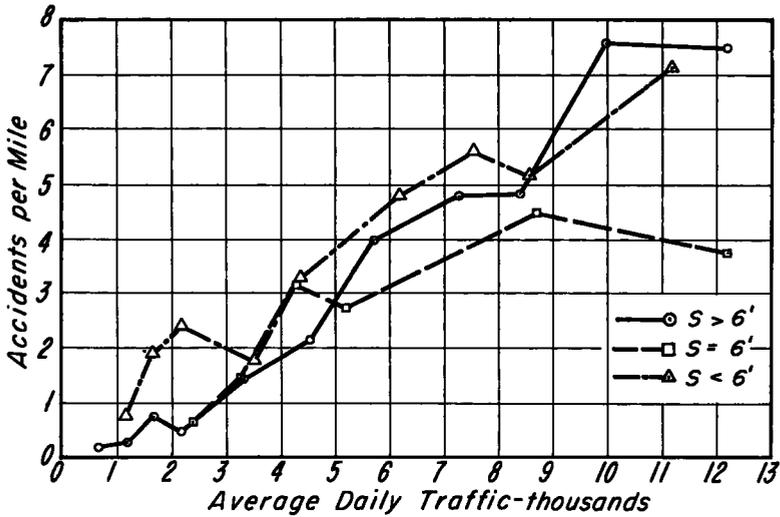


Figure 1. Observed relation between accident rates and shoulder widths.

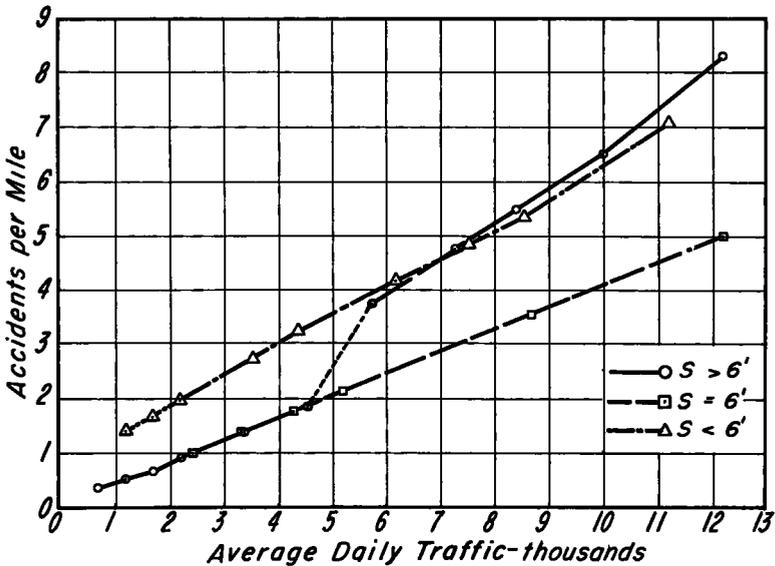


Figure 2. Theoretical relation between accident rates and shoulder widths.

about 6 feet may have serious disadvantages. For example, in congested traffic they may be used for passing on the right.

Such considerations lend support to the conclusions reached by the statistical analysis. The data analyzed contain, however, several weaknesses — some curves are included, for example, and there is a scarcity of 6-foot shoulder points at high volumes. The conclusions must therefore be regarded as being far from def-

initely established. It may be noted that they receive considerable confirmation from Raff's results (1), which also point to an optimum shoulder width somewhere between 5 feet and 8 feet. The negative conclusions reported by Raff are apparently based on the absence of a significant linear relationship between accident rates and shoulder widths. This would be quite compatible with the more-complicated relationship found in the present paper.

## REFERENCES

1. Raff, Morton S. , "Interstate Highway-Accident Study," in Traffic-Accident Studies, Bulletin No. 74, Highway Research Board, 1953. Table 9, p. 28.
2. Taragin, A, and Eckhardt, H. G. , "Effect of Shoulders on Speed and Lateral Placement of Motor Vehicles," Proceedings, Highway Research Board, v. 32, 1953, p. 371-382.