CHAPTER 2 Accident Data Relationships

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Surface Friction and Traffic Accidents

Traffic accidents can be complex events. To assume that traffic accidents, or a given subset of traffic accidents (e.g., accidents that result from inadequate surface friction), can be accurately predicted on the basis of one antecedent condition such as skid number is wishful thinking.

Making the situation even more difficult is that accidents are rarely categorized as resulting from inadequate surface friction. Instead, some surrogate for inadequate friction must be found. The usual candidate is wet surface accidents. The tacit assumption in choosing this surrogate is that an accident that occurs on a wet surface is the result of inadequate friction. As Hegmon (1) points out, accidents that occur on wet surfaces may or may not be associated with inadequate friction. It follows that it is extremely difficult to predict wet surface accidents solely on the basis of skid number.

In a recent review of the literature on the association between wet surface accident rate and skid number, an unsatisfactory association between the two measures was demonstrated (2). In that review a simple linear regression of wet accident rate on skid number (SN_{70}) was calculated for data contained in Rizenbergs et al. (3). The resulting equation was

$$AR = 31.80 - 0.55\ SN \qquad (1)$$

where AR is the wet accident rate (wet accidents per 100 million vehicle miles), and SN is the skid number (SN_{70}) predicted for a speed of 70 mph. This equation accounted for 8.7 percent of the variance in wet accident rate.

This same regression procedure was then applied to a second set of data provided by Rizenbergs et al. (4). In this case the resulting equation was

$$AR = 101.58 - 1.51\ SN \qquad (2)$$

(Note that for this second data set skid numbers were recorded at 40 mph.) This second regression equation accounted for 9.6 percent of the variance in the wet accident rate.

Equation 1 was based on data from rural, four-lane, controlled-access highways. Equation 2 was based on rural, two-lane roads. The low values of 8.7 and 9.6 percent indicate that skid number alone is not extremely helpful in predicting wet weather accident rates.

It should be recognized that the frictional properties of a road surface are not inherently adequate or inadequate. Rather, those surface properties are adequate or inadequate in terms of specific vehicle maneuvers--stopping, turning, accelerating (i.e., vehicle demand for friction). This fact has been recognized directly or indirectly in a number of studies (5-10).

In the study by Ivey and Griffin (5), wet weather accidents were used as a surrogate for accidents that result from inadequate friction. Several variables were used as surrogates for vehicle demand for friction:

ADT = average daily traffic,
ACC = access (a standardized subjective scale of roadway congestion),
SN = skid number at 40 mph,
TW = proportion of time wet,
VM = mean traffic speed,
V = variation in traffic speed (one standard deviation from the mean), and
LN = lanes of traffic.

For 32 segments of highway on high-speed roads (55 mph), wet accident rates (WARs) ranged from 0 to 6.56. Approximately 58 percent of the variance in WAR could be accounted for by the following standard multiple linear-regression equation:

$$WAR = -21.7 + 0.0009\ ADT + 2.34\ ACC - 0.40\ SN + 286\ TW + 1.32\ LN \qquad (3)$$

(Note that the units of WAR are wet pavement accidents per mile per year).

For 36 segments of highway on low-speed roads (<55 mph), the WARs ranged from 0 to 40.41. Approximately 46 percent of the variance in WAR could be accounted for by the following standard multiple linear-regression equation:

$$WAR = -0.75 + 0.0001\ ADT - 0.053\ VM + 0.54\ V + 0.69\ ACC - 0.025\ SN \qquad (4)$$

Although Equations 3 and 4 still leave a large portion of the variation in the dependent variable unaccounted for, note that by tacitly taking demand for friction into account in these equations, much greater accuracy is achieved in predicting WAR than would have been possible on the basis of SN alone. This is emphasized by comparing the values of 58 and 46 percent (which roughly account for half the variation) to the values of 8.7 and 9.6 percent (which account for roughly one-tenth of the variation).

Surface Discontinuities and Traffic Accidents

The literature on the relationship between roadway discontinuities and traffic accidents is limited. Two studies, however, are applicable.

Ivey and Griffin (11) examined 15,968 single-vehicle accidents that occurred in North Carolina in 1974. Police officers' narratives for all 15,968 accidents were read by automated means. Any narrative that contained 1 of 19 key words (e.g., dip, rocks, rut, edge) was printed out and reviewed by the authors to determine if that accident resulted from, or was aggravated by, a roadway discontinuity. Approximately 566 (3.5 percent) of the 15,968 accidents were associated with roadway disturbances.

The data in Table 1 are adapted from the original report. Note that police accident reports are not always correct in indicating the elements that contribute to a specific accident because of a wide variation in experience and capability. Nevertheless, even with this known shortcoming, the key-word-narrative data-retrieval system developed by the North Carolina Highway Safety Research Center is a powerful tool.

TABLE 1 Number of Accidents from Discontinuity (Key Word)

Disturbance	Frequency	Disturbance	Frequency
Water	143	Patch	11
Dropped	73	Bump	9
Soft	71	Dip	9
Curb	62	Rocks	4
Edge	59	Ruts	4
Hole	34	Track	3
Rail	24	Rut	2
Drop	23	Manhole	2
Rock	19	Bumps	2
Surface	12	Total	566

The authors inferred that approximately half of the accidents reported in Table 1 resulted from a disturbance off of the traveled surface (e.g., "which dropped off the pavement," "vehicle hit curb and overturned") and half resulted from disturbances in the lane of travel (e.g., "vehicle hit bump in road," "ruts in road caused loss of control").

Klein et al. (12) reviewed accident data from three sources: California accident data (police level data), collision performance and injury report (CPIR) data provided by the Highway Safety Research Institute of the University of Michigan, and Indiana accident data (levels II and III) provided by Indiana University. Their findings are based on 23 hard copies from the California files, 26 from the Michigan files, and 22 from the Indiana files. The authors conclude that the most significant roadway disturbance is shoulder drop-off, closely followed by loose material on roadway. Lesser disturbances include potholes, rough roads, dips, and roadway design faults.

Although most authorities would agree that road surface discontinuities may precipitate or aggravate accidents, the magnitude of the problem is unknown. Indeed, the relative hazard of different disturbances and discontinuities is not well known.

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