

Binary Probit Crash Analysis For Various Curve And Grade Conditions

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Introduction and background

Traffic crashes have various causes ranging from environmental issues, driver ability levels, overall distractions, sight distance limitations, to basic roadway geometrics. Table below shows severe crashes that happened in different geometries:

| Straight and Level | Straight and Downgrade | Straight and Upgrade | Curve Left and Level | Curve Left and Downgrade | Curve Left and Upgrade | Curve Right and Level | Curve Right and Downgrade | Curve Right and Upgrade |
|--------------------|------------------------|----------------------|----------------------|--------------------------|------------------------|-----------------------|---------------------------|-------------------------|
| 4.98% | 6.95% | 6.08% | 12.49% | 13.88% | 11.51% | 7.95% | 11.11% | 8.44% |

This paper presents data that were collected and analyzed using a binary probit model to determine the characteristics associated with higher crash severity of different grades (level, upgrade and downgrade) along with curve conditions (straight, turning left and turning right).

Data Collection

The data used in this analysis were extracted from the Critical Analysis Reporting Environment (CARE) maintained by the Center for Advance Public Safety at the University of Alabama. Data were separated by horizontal curvature movement (left or right) and vertical alignment (level, upgrade or downgrade). There were six unique datasets developed for which the crash models were developed. The number of crash observations that are available for each of the six categories is shown in Table 2.

| Curve Left and Level | Curve Left and Downgrade | Curve Left and Upgrade | Curve Right and Level | Curve Right and Downgrade | Curve Right and Upgrade |
|----------------------|--------------------------|------------------------|-----------------------|---------------------------|-------------------------|
| 8,231 | 7,247 | 3,588 | 6,111 | 5,494 | 2,835 |

Model results

- In this study it was shown that driving when not distracted, having a sideswipe crash, driving under normal operating conditions, being younger, and driving in dry conditions are the factors that have the least severity.
- Some key elements that increase severity on all the roadways geometrics and grades from the primary contributing circumstances include driving too fast for conditions, driving under the influence, running off the road, improper driving and swerving to avoid vehicle or animal.

| Parameter (B) | Left and Downgrade | Left and Level | Left and Upgrade | Right and Downgrade | Right and Level | Right and Upgrade |
|--|--------------------|----------------|------------------|---------------------|-----------------|-------------------|
| [Time of Day=Morning peak] | | | | -.145 | -.302 | |
| [Primary Contributing Circumstance=defective equipment] | | | | | .423 | |
| [Primary Contributing Circumstance=Distracted by Phone/Passenger/Insect/Reptile] | | .324 | .476 | | .478 | |
| [Primary Contributing Circumstance=Driving too Fast for Conditions] | .551 | .702 | .911 | .736 | .862 | .486 |
| [Primary Contributing Circumstance=DUI] | .485 | .583 | .697 | .573 | .789 | |
| [Primary Contributing Circumstance=E Fatigued/Asleep] | | | .956 | | .676 | |
| [Primary Contributing Circumstance=E Ran off Road] | .484 | .672 | .749 | .634 | .691 | .622 |
| [Primary Contributing Circumstance=Improper Driving] | .389 | | .570 | .694 | .676 | .437 |
| [Primary Contributing Circumstance=Swerved to Avoid Vehicle/Animal] | | | .525 | .378 | .489 | |
| [Distracted Driving=Not Distracted] | -.124 | | | -.124 | | -.208 |
| [Manner of Crash=Angle] | | .263 | | | | |
| [Manner of Crash=Head-On] | | .411 | .605 | .375 | .664 | .768 |
| [Manner of Crash=Rear End] | | | | -.309 | -.276 | |
| [Manner of Crash=Sideswipe] | -.446 | -.384 | -.417 | | -.330 | |
| [Lighting Conditions=Dark - Spot Illumination] | | | -.1937 | | | |
| [Weather=Clear/Cloudy] | | | .797 | 1.000 | | |
| [Weather=Fog] | | | 1.132 | | | |
| [Weather=Rain/Mist] | | | .726 | .821 | | .738 |
| [Landuse=Open Country] | | .514 | | | | .652 |
| [Landuse=Residential/School/Playground] | | | | | | .737 |
| [Causal Unit Age=Adult] | | | | .154 | .158 | |
| [Causal Unit Age=Older Adult] | .200 | .135 | .249 | .261 | .163 | |
| [Causal Unit Age=Retirees] | .236 | .176 | .304 | .223 | .218 | |
| [Causal Unit Age=Young] | -.179 | -.136 | -.191 | | | |
| [Driver Condition=Apparently Normal] | -.480 | -.473 | -.384 | -.718 | -.699 | -.674 |
| [Driver Condition=Asleep/Fatigued] | | | | | -.774 | -.917 |
| [Driver Condition=Emotional] | | | | | -.736 | -1.217 |
| [Driver Condition=Influence of Alcohol/Drugs] | .242 | .255 | | .344 | .461 | |
| [Speed Limit=<45mph] | | | | | .095 | |
| [Roadway Condition=Dry] | -.139 | -.163 | -.342 | -.169 | -.249 | |

- In reviewing the data, the specific contributing circumstance of running off the road was nearly the highest factor that led to increased crash severity for each of the curve and grade classifications.

| Parameter B | Left and Downgrade | Left and Level | Left and Upgrade | Right and Downgrade | Right and Level | Right and Upgrade |
|--|--------------------|----------------|------------------|---------------------|-----------------|-------------------|
| [Time of Day=Morning peak] | -.186 | | | | | |
| [Primary Contributing Circumstance=defective equipment] | | .858 | 1.057 | | .650 | |
| [Primary Contributing Circumstance=Distracted by Phone/Passenger/Insect/Reptile] | | .886 | | .520 | .633 | .634 |
| [Primary Contributing Circumstance=Driving too Fast for Conditions] | .357 | .916 | 1.021 | .657 | .861 | .650 |
| [Primary Contributing Circumstance=DUI] | .525 | 1.163 | 1.249 | .710 | 1.009 | |
| [Primary Contributing Circumstance=Fatigued/Asleep] | | .784 | 1.091 | | 1.013 | |
| [Primary Contributing Circumstance=Improper Driving] | | .845 | | | .522 | |
| [Primary Contributing Circumstance=Misjudge Stopping Distance] | | | | .985 | 1.006 | |
| [Primary Contributing Circumstance=Swerved to Avoid Vehicle/Animal] | | .844 | 1.070 | .519 | .778 | .643 |
| [Distracted Driving=Not Distracted] | -.314 | -.463 | -.338 | -.368 | -.244 | -.366 |
| [Lighting Conditions=Dark - Spot Illumination] | | | | | -1.041 | |
| [Lighting Conditions=Daylight] | | | | | -1.102 | |
| [Lighting Conditions=Dusk/Dawn] | | | | | -.983 | |
| [Weather=Rain/Mist] | | | -.712 | | | |
| [Causal Unit Age=Adult] | .132 | | | | | |
| [Causal Unit Age=Older Adult] | .162 | | | | | |
| [Driver Condition=Emotional] | | | | | .730 | |
| [Speed Limit=<45mph] | .131 | | | .128 | | |

- Run-off road crashes are almost always caused by driver error, with limited impact of the environment or traffic control conditions.
- For drivers turning right on level conditions, the addition of roadway lighting or driving during daylight hours significantly reduced the likelihood of a run off the road crashes.
- Driving while distracted or in a fatigued state or under the influence of drugs or alcohol significantly increased the number of run off the road crashes.