SAFETY ANALYSIS ON RAIL HIGHWAY AT-GRADE CROSSING IN ALABAMA

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University Transportation Center for Alabama (UTCA)

Center for Advanced Public Safety (CAPS)

Safety performance function (SPF) development
- In line with the Highway Safety Manual (HSM)
- SPFs for two-lane rural roads, four-lane divided highways, urban/suburban arterials, highway bridges, and rail highway at-grade crossings, based on Alabama data.

Highway safety plan development
- Comprehensive Highway Safety Plan
- Strategic Highway Safety Plan
Outline

- Background of Study
- Objective of Study
- Data Description
- Modeling Methodology
- Modeling Results
- Conclusion
- Future Research
Background of Study

What can make RHGCs safer?

- Track and signal inspection and maintenance
- Warning device upgrade
- Educate the public about proper behavior at RHGCs
Background of Study

Available Funds

Effectively utilized

Ranked list of RHGC for improvements:
1. RHGC #2
2. RHGC #1
3. RHGC #3
...

Through appropriate ranking program

RHGC #1
RHGC #2
RHGC #3
RHGC #4

...
The crash prediction model from the RHGC safety assessment approach recommended by the US Department of Transportation:

- Base formula* (1986)
- Weighted formula for observed crashes* (1986)
- Final adjustment for current collision trends** (2007)

Related studies

- RHGC crash analysis (influencing factors, prediction model)
- Effective analysis of warning devices at RHGCs (e.g., stop sign)

Objective of Study

- Develop safety performance functions (SPFs) for crashes occurring at RHGCs in line with the Highway Safety Manual (HSM).
- Tools and techniques to integrate safety into transportation planning
- Predictive method gives expected average crash frequency

- Understand how RHGC characteristics affect crash occurrences.
Data Description

Data Sources

Federal Railroad Administration (FRA) database
- Highway-rail crossing inventory
- Highway-rail crossing history file
- Highway-rail crossing accident database

Alabama Department of Transportation (ALDOT) database
- Rail-highway at-grade crossing inventory
Crash Facts

- 1,332 crashes occurred from 1998-2012.
- RHGC crashes generally increased from 2009-2012
## Data Description

15-year Crash observations at 2,720 RHGCs

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>306359C</td>
<td>Attributes that represents the latest statuses of crossings</td>
<td>2</td>
<td>1</td>
<td>0</td>
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<tr>
<td>726916V</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>...</td>
<td></td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Data processing to make sure:

- Each sample is from a five-year interval without changes of the crossing.
- Each sample has the corresponding status of the RHGC.

FRA highway-rail crossing history file

Final sample set for modeling (2,198 samples)
Modeling Methodology

- **Data Analysis**
  - Crashes are rare and random events
  - Discrete count models
  - Observed crash counts as over-dispersed data
  - Negative Binomial model (NB2 formulation)

- **Best Model Identification (goodness of fit)**
  - Log-likelihood value
  - Akaike Information Criterion (AIC)

- **Model Validation**
  - Validation date set
  - Model validity measures
Modeling Methodology

Crash data set

Training set

Validation set

Candidate Negative Binomial regression models (NB2 formulation)

*NLOGIT*4.0

Log-likelihood value & AIC

Potential best model(s)

Best model

Validity measures
Modeling Development

- Variable description
  - Crash count over five consecutive years for a crossing serves as the dependent variables.
  - 152 variables from the crossing inventory.
  - Many variables are redundant giving same information.
  - Many variables not included in the analysis because of missing values and description.
  - 60 variables were shortlisted for detail investigation.
  - After further investigation 27 variables were used in the model.
## Modeling Results

### SPF for Alabama RHGC crashes

<table>
<thead>
<tr>
<th>Variables</th>
<th>Best model</th>
<th>Comparable model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-6.0066</td>
<td>-5.2083</td>
</tr>
<tr>
<td>LnAADT</td>
<td>0.3388</td>
<td>0.1978</td>
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<tr>
<td>Percentage truck</td>
<td>0.0228</td>
<td>0.0246</td>
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<tr>
<td>Number of bells</td>
<td>-0.5593</td>
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</tr>
<tr>
<td>Variable indicating at least 1 train per day</td>
<td>-1.269</td>
<td></td>
</tr>
<tr>
<td>Pavement markings</td>
<td>0.2967</td>
<td>0.2378</td>
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<tr>
<td>Max train speed</td>
<td>0.0219</td>
<td></td>
</tr>
<tr>
<td>Minimum train speed</td>
<td>0.013</td>
<td>0.0271</td>
</tr>
<tr>
<td>Dispersion Parameter</td>
<td>1.7198</td>
<td>2.0929</td>
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<tr>
<td>Log-Likelihood</td>
<td>-366.182</td>
<td>-371.133</td>
</tr>
<tr>
<td>AIC</td>
<td>0.759</td>
<td>0.765</td>
</tr>
</tbody>
</table>
Conclusion

- Developed the safety performance function (SPF) for rail-highway at-grade crossings in Alabama.
  - Two models currently are viable.
  - The U.S. DOT model contains variables that are irrelevant to the prediction of RHGC crashes, at least in Alabama.

- The models are based on Alabama data
  - Alabama-specific RHGC SPFs may not apply in other states.
  - Test using calibration factor or develop new SPFs.
Future Research

- Use Conway–Maxwell–Poisson (CMP) distribution to model crash counts at RHGCs.
  - Advantages of CMP –
    - Very flexible and spans over three distribution (Geometric, Poisson and Bernoulli)
    - Performs well for both over-dispersed and under-dispersed data set
  - Motivation of using CMP –
    - Model RHGC crash counts at different levels of severity
- Work with ALDOT to develop a ranking program to prioritize RHGCs for improvements.
Thanks!

Questions / Comments?
**USDOT Accident Prediction Model**

- $EI =$ factor for exposure index based on product of highway and train traffic
- $MT =$ factor for number of main tracks
- $DT =$ factor for number of through trains per day during daylight
- $HP =$ factor for highway paved (yes or no)
- $MS =$ factor for maximum timetable speed
- $HT =$ factor for highway type
- $HL =$ factor for number of highway lanes

**HSM Methodology Prediction Model**

- Train Speed (Max and Min)
- AADT
- Truck Percentage
- Warning device Present
- Pavement Markings
- Train Activity ($< 1$ per day)