CONSTRUCTION MANAGEMENT AND TECHNOLOGY

Risk Mitigation Strategies for Operations and Maintenance Activities

tech transfer summary

The ultimate goal is to reduce the frequency and intensity of loss events (property damage, personal injury, and fatality) during operations and maintenance activities.

Problem Statement

Previous research on construction work-zone safety found that moving operations represent the highest-risk activity when considering both frequency of occurrence and crash severity (Shane et al. 2009). The research further determined that using an integrated risk model that assesses risk over the project life cycle could mitigate the risk of moving operations (among others) during the construction phase.

Hence, this research examines how an integrated risk-modeling approach could be used to reduce the frequency and intensity of loss events (property damage, personal injury, fatality) during highway operations and maintenance (O/M) activities.

Objective

The objective of this research is to investigate the application of integrated risk modeling to O/M activities, specifically moving operations such as pavement and structures testing, pavement marking, painting, shoulder work, mowing, and so forth.

Research Description

The methodologies that were adopted in this research are as follows:

- Identification of current O/M processes through expert input
- Literature review
- Analysis of crash data
- Validation survey
- Identification of mitigation strategies

Cone shooters can automatically place and retrieve traffic cones to open and close busy lanes safely and quickly without exposing workers to traffic (photo Copyright © AHMCT Research Center - UC Davis, 2010)

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RESEARCH PROJECT TITLE
Risk Mitigation Strategies to Improve Safety of Transportation Operations and Maintenance Activities

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The Construction Management and Technology (CMAT) Program is part of the Institute for Transportation (InTrans) at Iowa State University. The mission of CMAT is to improve the efficiency and cost-effectiveness of planning, designing, constructing, and operating transportation facilities through innovative construction processes and technologies.

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Identification of Current O/M processes through Expert Input

The research started with an expert panel session/ brainstorming workshop with the technical advisory committee (TAC) aimed at mapping the O/M process as currently utilized by state, county, and local agencies. The objective was to categorize the activities, environments, tools/equipment, and relationships involved with different O/M functions.

This session was followed up by in-depth interviews with three members of the expert panel.

Literature Review

The researchers performed an extensive literature search compiled a preliminary list of risk factors and loss events during O/M activities. The search mainly included results from academic journals, trade publications, transportation research technical reports, and state departments of transportation (DOT) web sites.

The literature review reveals several studies on the impacts of weather on the roadways and, hence, its effects on work-zone safety, along with specific research on the interaction of traffic and O/M and mobile work-zone-related safety. However, these studies did not specifically address risk assessment and mitigation strategies for the O/M activities on highways.

The literature search also gave insight into how the identified factors play a role in mobile work-zone crashes, specifically work zones that involve O/M activities on highways.

Analysis of Crash Data

The analysis of the crash database provided by the Iowa DOT played a very important role in the development of the Integrated Risk Management Model. To obtain information about the relevant crashes, a query was created to gather data for all severity level of crashes from 2001 through 2010 that involved two types of work zones: intermittent or moving work and work on shoulder or median.

The suitable variables in the crash database that were able to explain the effect of the previously-identified factors (activities, environment, tools/equipment, and relationships) were queried to analyze their effect on crash severities and the frequency with which they occur within the database.

The Integrated Risk Management Model consists of two parts: factors contributing to the severity of the crash and the frequency of the factors involved in the crashes. In this research study, the significance of the factors contributing to the severity of the crash was assessed by developing a statistical model and the frequency of those factors that were found to be significant in the model was assessed through descriptive statistics of the crash database.

The researchers examined weather (environment), equipment, activities, and related factors to develop a risk severity matrix to indicate the relative severity of each factor on a Likert scale of 1 to 5. By performing an analysis of the crash database, the researchers generated a model (and refined it) to show the relationships between the various factors and the severity and frequency of crashes in mobile work zones.

Validation Survey Data Analysis Results

The loss events identified in the literature review and crash data analysis were validated in a short survey that was administered to state, county, and local O/M personnel, as well as to traffic safety professionals in the private sector, including both office and field personnel. The survey assisted the research team in ranking loss events in order of risk (frequency and severity).

The survey questions included the O/M activities identified from the expert panel session. The participants were asked to rank those activities from their experience according to their severity and likelihood of occurrence (frequency), both of which were measured with a Likert scale rank value from 0 to 5.

The number of responses obtained was 24. Because of the small sample size, no statistical tests were performed with the survey results. These results were used only to validate the results obtained through the statistical analysis of the crash database.

Identification of Mitigation Strategies

After identifying potential risk factors, establishing proximate causes, and estimating frequency and severity, the research team identified risk mitigation strategies that could be used to reduce the frequency and/or severity of losses during O/M activities. The potential mitigation strategies were identified after a meeting with the TAC members.

Key Findings

After identifying potential risk factors and evaluating loss severity, the research team identified the following risk mitigation strategies that can be used within integrated teams to reduce the frequency and/or severity of losses during O/M activities.

1. Revise and integrate the Iowa DOT Instructional Memorandums (IM), Traffic and Safety Manual, and Standard Road Plans – TC Series (traffic control diagrams) and related notes to provide clear, comprehensive, and easily-accessible guidance on placement of traffic control measures for mobile work zones.

2. Consider expanding traffic-control options to include proven technologies such as the Balsi Beam, portable rumble strips, blue strobe lights, and other innovations.

Traffic-control specifications and associated allocation of risk between contractors and state/local agencies would also need to be revised to encourage adoption of new traffic-control measures. This is an area where a follow-up study would prove beneficial.

3. Investigate new delivery technologies (such as Skype, webinars, and remote conferencing) to allow for improved training within the flattened structure of the Iowa DOT. The training should include both formal programs for centralized functions and informal weekly programs for supervisory personnel to discuss issues with field crews. The Local Technical Assistance Program (LTAP) at the Institute for Transportation (InTrans) may be of assistance in developing such a safety-training program. The safety-training program will be particularly helpful for new and temporary employees working in mobile operations.

4. Written manuals and training programs should focus on the importance of worker and equipment visibility and advance warning systems, especially in high-speed environments (interstates and US highways) and those where drivers may be distracted more easily by pedestrians, traffic signals, bicyclists, etc., such as municipal streets.

Robotic safety barrels show promise in reducing the number of workers and vehicles required to close lanes and move lane closures at the same pace as the mobile operations

5. Schedule Best Practices meetings regularly within divisions. Encourage shop management to meet with division managers and other shop managers to discuss best practices that are discovered in the field, especially when it comes to safety. Division managers should also hold meetings periodically to encourage this type of information sharing. The alternative delivery technologies mentioned above may also be helpful in disseminating best practices.

6. Certain environments should be reviewed to ensure that the minimum number of workers and vehicles are used in the traffic-control system. Specifically, two lane two-way highways, work at railroads and other utility sites, overhead work, and work on bridges are likely high-risk environments where additional vehicles and workers increase the risk of crashes. The value of impact attenuators should be researched to determine the safety benefits of such equipment. The analysis of the crash database did not find any reports of impact attenuators associated with mobile work-zone crashes.

7. Policies and safety training programs should emphasize the need for locating traffic controls at the appropriate distance from the work site to allow for driver reactions, and traffic controls should be moved at the same pace as the mobile operations whenever possible.

The research report includes a comprehensive discussion of findings beyond what's included in this summary.

Portable rumble strips are very easy to use and one or two workers can deploy them from the back of a pick-up truck

Research Limitations

The limitations of this research study are as follows.

- All of the factors/hazards that were studied in this research could not be described by the crash database variables queried. Representative variables were selected and analyzed from the crash database, which indirectly explained the effect of the required variables/factors/hazards. The data entered on the responding officer's report does not always match the variable of interest.
- The crash data were drawn from the Iowa crash database, but the survey and literature review was national in scope. This made the research study somewhat biased.
- To get a good sample size, crash data from the last 10 years (2001 through 2010) were analyzed. This may have included information about several crashes that occurred after changes in work-zone signage practices and other infrastructure development.
- The response rate for the validation survey was low. Because of the sample size, no statistical analysis could be performed.

Implementation Readiness

The possible mitigation strategies developed as a result of this research are not field-tested, as that was outside of the scope of this project.

If further research on the implementation ideas is needed, a separate research study can be conducted focusing on the implementation of the risk-mitigation techniques found as a result of this study.

Testing may include evaluation of the risk-mitigation strategies in simulators or actual field situations to determine effectiveness.

Developed by the California Department of Transportation (Caltrans), the Balsi Beam has great potential for protecting exposed workers in short-duration work operations

Implementation Benefits

The research findings are intended to provide a process map or guidebook outline for use by the Iowa DOT, Iowa county engineers, and municipal transportation agencies to assess the risk potential of various O/M activities and develop team-based risk-mitigation strategies.

The primary benefits of this research are the reduced risk of injury, fatality, and property damage for O/M workers and the traveling public. The research results can be implemented by the Iowa DOT staff, county engineers, municipal transportation directors, and any other transportation professionals responsible for O/M activities, including field personnel.

The results can also be used as a standard process for identifying highest-risk O/M activities and developing mitigation strategies to reduce those risks. However, it should be noted that the risk-mitigation processes developed and envisioned in this research are highly inclusive, involving state, local, and regional professionals from both field and office positions.

Intuitively, any process that decreases risk should improve worker safety, lower agency costs, improve service to the traveling public, and lead to more-efficient procedures over the long-term, although these specific performance benefits are not assessed directly as part of this research project.

Truck-mounted changeable signs enable message delivery close to the actual work site (photo Texas A&M University-Kingsville)