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Transportation Construction Work-Zone Safety Impact on Time-Related Incentive Contracting Projects

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MTI Report WP 12-11

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REPORT WP 12-11

TRANSPORTATION CONSTRUCTION WORK-ZONE SAFETY IMPACT ON TIME-RELATED INCENTIVE CONTRACTING PROJECTS

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16. Abstract

Work-zone safety on highway projects continues to be a national concern, and project safety performance is one of the indicators of project success. Many contractors and State Transportation Agencies believe that expedited construction time under incentive contracting contributes to reducing the safety risk of road users traveling through work zones. However, the truth of this belief has never been measured or supported by any statistical evidence. Therefore, this research investigates the statistical relationship between time-related incentive road construction projects and frequency of vehicle crashes in California to understand the impact of time-related incentive provisions on project safety performance. The research team collected incentive and non-incentive project data from the California Department of Transportation. Additionally, vehicle crash data was collected from the California Statewide Integrated Traffic Records System. Using Geographic Information System (GIS) software, the locations of construction projects and crashes at the project locations were then pinpointed on GIS centerline layers. The research team performed statistical analyses to test the relationship between the frequency and characteristics of crashes at incentive project sites and ones at non-incentive project sites before, during, and after construction. Finally, the analysis results for both time-related incentive projects and non-incentive projects were summarized to provide project planners and managers with a better understanding of the impact of time-related incentive contracting on project safety performance.

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EXECUTIVE SUMMARY

RESEARCH BACKGROUND AND OBJECTIVE

Work-zone safety on highway projects continues to be a national concern, and project safety performance is one of the indicators of project success. Contractors and State Transportation Agencies believe that expedited construction time under incentive contracting contributes to reducing the safety risk of road users traveling through work zones. Nevertheless, the truth of this belief has never been measured or supported by any statistical evidence. Obviously, understanding the impact of time-related incentive provisions on project-safety factors is important in order to provide better guidelines for the effective use of incentives, as well as for construction work-zone safety. Improving the current practice for time-related incentive provisions through the implementation of the research findings will provide the traveling public with increased value and safety.

The goal of this research, therefore, is to investigate the statistical relationship between time-related incentive road construction projects and frequency of vehicle crashes in the State of California and provide project planners and managers with a better understanding of the impact of time-related incentive contracting on project safety performance.

RESEARCH METHODOLOGY

This research started with a narrow literature review with regard to time-related incentive contracting performances and work-zone safety studies. The research team also collected incentive and non-incentive project data from the California Department of Transportation (Caltrans). In addition, vehicle crash data was collected from the California Statewide Integrated Traffic Records System (SWITRS). Using Geographic Information System (GIS) software, the locations of construction projects and crashes at the project locations were then pinpointed on GIS centerline layers. Finally, statistical analyses were performed to investigate the relationship between the frequency and characteristics of crashes at incentive project sites and ones at non-incentive project sites in the State of California. The results of these analyses about how the current project incentive systems impact on construction work-zone safety were summarized.

RESEARCH OUTCOMES

The research team successfully compiled data representing the locations of construction work zone and crashes using GIS technology and performed statistical analyses to compare the frequency of crashes at time-related incentive construction project site before, during, and after construction.

An analysis of variance (ANOVA) test for both time-related incentive projects and non-incentive projects was performed to test if the occurrence of crashes is significantly different among three scenarios: 1) Before Construction, 2) During Construction, and 3) After Construction. The statistical analysis results for both projects show that the differences of crash occurrence among all three variables are not significant. This indicates that there is no adverse safety impact on time-related incentive contracting projects during the study period. No statistical evidence was found that time-related incentive contracting projects have a negative impact on work-zone safety performance.

Although there was no work-zone safety difference among three scenarios, it is noted that the number of project data used for this study was small and limited. Only 19 time-related incentive projects and 13 non-incentive projects were collected and summarized in Appendix A and B, respectively. Approximately 10% of all incentive project data implemented in California has been collected during the research period and tested for this study. Therefore, in order to draw a more meaningful conclusion, it is necessary for the research team to collect more project data for each category and perform a statistical analysis with a large sample size.

I. INTRODUCTION

RESEARCH BACKGROUND

The Federal Highway Administration (FHWA) strives to improve work-zone safety. At the same time, the FHWA endeavors to enhance the transportation system by striving for the early delivery of highway construction projects by encouraging State Transportation Agencies (STAs) to implement time-related incentive contracting for early completion of time-sensitive highway construction projects, including urban rehabilitation and reconstruction. In many states, including California, the STAs have successfully implemented time-related incentive contracting methods. While there have been numerous studies published regarding time performance of the incentive contracting projects, there has been no quantitative research effort made to measure the safety performance of expedited incentive construction projects. It is also unknown whether or not a contractor's accelerated work schedule under time-related incentive contracting has a positive or negative impact on work-zone safety performance.

Work-zone safety on a highway project continues to be a national concern, and project safety performance is one of the indicators of project success. Contractors and STAs believe that the expedited construction time under incentive contracting contributes to reducing the safety risk of road users traveling through work zones. Nevertheless, this proposition has never been measured or supported by any statistical evidence. Therefore, understanding the impact of time-related incentive provisions on project safety factors is important to provide better guidelines for the effective use of incentives, as well as construction work-zone safety. Improving the current practice for time-related incentive provisions through the implementation of the research findings will provide the traveling public with increased value and safety.

This research will focus on determining the significance of the frequency of vehicle crashes for time-related incentive road construction projects in the State of California. Using state-of-the-art GIS technology, this research will compile data representing the locations of construction work zones and crashes. Then, using statistical analyses, the research team will compare the frequency of crashes at incentive project sites with those at non-incentive project sites.

In conclusion, the outcome of this research will provide a better understanding of the frequency of crashes at construction work zones during the current time-related incentive contracting practices. The goal of this study is to contribute to developing a framework of a safety-oriented incentive policy for the nation's highway system in the future.

RESEARCH OBJECTIVE

The goal of this research is to investigate the statistical relationship between time-related incentive road construction projects and the frequency of vehicle crashes in the State of California and provide project planners and managers with a better understanding of the impact of time-related incentive contracting on project safety performance.

RESEARCH SCOPE AND METHODOLOGY

In order to achieve the research objective, the scope of this research includes a narrow literature review with regard to time-related incentive contracting performances and work-zone safety studies. The research team then collected incentive and non-incentive project data from Caltrans: 1) project location information (District, County, Roadway ID/Name, Postmile ahead, Postmile back, Speed limit, Number of lanes), 2) project duration (Work begin date and Final acceptance date), 3) project contract amount, and 4) project work type. In addition, vehicle crash data was collected from SWITRS. The collected crash data was included in the project database. These crash data containing specific location information were needed if they were to be linked to construction projects. Using GIS software, the locations of construction projects and crashes at the project locations was pinpointed on GIS centerline layers. Statistical analyses were performed in order to find any relationship between the frequency of vehicle crashes and time-related incentive projects. The overview of this research methodology is illustrated in Figure 1.

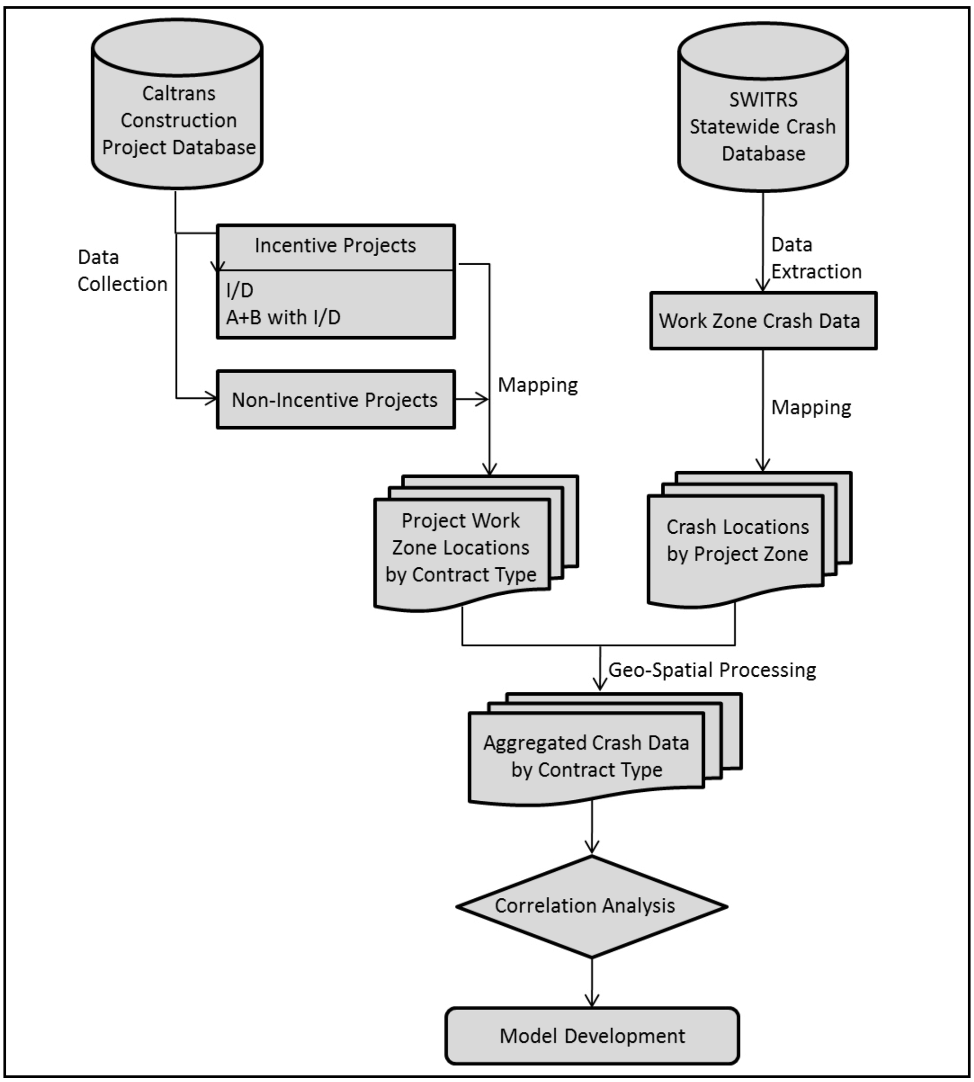

Figure 1. Overview of Research Methodology

II. LITERATURE REVIEW

The research team conducted a literature review of time-related incentive contracting performances and work-zone safety studies. A narrow focused study regarding incentive contracting performance evaluations and a regional perspective of construction zone safety was reviewed and briefly summarized.

TIME-RELATED INCENTIVE CONTRACTING

The FHWA initiated an alternative contracting policy for Incentive/Disincentive (I/D) for Early Completion under FHWA's Special Experimental Project No 14 - Innovative Contracting in 1989. Since then, the FHWA has encouraged STAs to implement time-related incentive contracting for early completion of time-sensitive highway construction projects. In practice, incentives may be paid when employing the following contracting practices: I/D, Cost plus time (A+B) with I/D, No Excuse Bonus (complete-by-date incentive), Lane Rental, Liquidated Savings, and any combination of those practices.[1] The I/D concept is designed to shorten construction duration by providing the contractor with a monetary reward for early completion and charging a monetary penalty for delay. The A+B bidding concept is also designed to reduce the overall contract duration by encouraging the contractor to bid the minimum number of project days with project costs in order to reduce the contractor's time cost for bidding. The No Excuse Bonus contract provision is generally used for providing a significant monetary incentive for the contractor's early or on-time completion of a project regardless of any unforeseen project conditions. The Liquidated Savings are the opposite concept of the existing Liquidated Damages. The Liquidated Savings usually offers the owner's direct cost savings caused by early project completion to the contractor. In many states, including California, the STAs have successfully implemented these incentive contracting methods.[2] While numerous studies have been published regarding time performance of incentive contracting projects,[3] no quantitative research effort has been made to measure the safety performance of expedited incentive construction projects. Work-zone safety performance on a project has been an important issue for many years, but it is not known if a contractor's accelerated work schedule under incentive contracting has a positive or negative impact on work-zone safety performance.[4]

Contractors and STAs believe that expedited construction time under incentive contracting contributes to reducing the safety risk of road users traveling through work zones, but this has never been measured or statistically analyzed.[5] Therefore, understanding the impacts of time-related incentive contracting on project-safety factors is important to provide better guidelines for the effective use of incentives, as well as construction work-zone safety. Through the implementation of the research findings, improving current practice for time-related incentive provisions will provide the traveling public increased safety and value.

WORK-ZONE SAFETY STUDIES

There have been numerous work-zone safety studies, and most of them are micro-level case studies that analyze limited numbers of work zones and only a few crash sites in particular work zones.[6] At the regional level, there are few studies linking and analyzing work zones and crash characteristics. These regional level work-zone safety analyses mainly focus on comparing characteristics of crashes at construction work zones to ones at non-work zones.[7] Most of these studies utilize GIS technology to identify the locations of crashes and construction work zones. The GIS technology facilitates data aggregation, which makes it possible to combine detail characteristics of crashes occurring at each construction work zone. Once the data is compiled, a series of statistical analyses are applied to identify the relationship between work zones and crash frequency.[8]

In order to investigate crash trends and patterns properly, it was recommended to collect crash data for at least three years.[9] Crash data can be acquired from the California Statewide Integrated Traffic Records System, a statewide database that serves as a means to collect and process data gathered from a collision scene.[10]

For the analysis of crash data using GIS, mapping crashes in GIS is an important process that converts text or tabular data to spatial data that locates crashes on a roadway map.[11] It is necessary to identify locations of crashes for analyzing patterns of those crashes.

Along with the Geocoding engine, it was recommended that a standard GIS location mapping algorithm, a customized GIS application, was needed to be utilized to map the collected crash records. since Geocoding is not fully capable of handling location information of crash data expressed as a distance and a direction from particular post-markers of roads.[12]

SUMMARY

In conclusion, it is unknown whether the expedited construction time under incentive contracting contributes to reducing the safety risk of the road users traveling through work zones. For this reason, a study the safety impacts of time-related incentive projects is needed. Based on the previous studies, it was found that a regional scale study utilizing GIS technology could provide a systematic approach to pinpoint locations of crashes. In addition, using the existing public GIS database, detailed characteristics of crashes in construction work zones can be easily retrieved. For a further analysis, it is necessary to compare the frequency and characteristics of crashes at incentive project sites with ones at non-inventive project sites. Eventually, the results of this analysis might be able to provide detailed insights into how current project incentive systems affect construction work-zone safety.

III. DATA COLLECTION

In this data collection stage, the research team collected incentive and non-incentive construction-project data from Caltrans. The project data collect from Caltrans includes project-location information such as District, County, Roadway ID/name, Postmile Ahead, and Postmile Back. Other key project information such as project duration, type of work and contract amount was also collected. In addition, crash data was acquired from the California Statewide Integrated Traffic Records System, a statewide database that serves as a means to collect and process data gathered from collision scenes.

Using GIS technology, the locations of construction projects and crashes was pinpointed. The project data of Caltrans were in the format of tabular data. The first mapping task was to identify the locations of the construction projects. Using location information in the database, the research team identified the locations of construction projects on the GIS highway centerline layers.

The location information of the project data was based on a combination of street names. For example, there was a construction project on University Avenue between 1st Street and 2nd Street. Since current GIS software is not capable of automatically pinpointing map locations based on available location information, a manual mapping process was necessary for searching the names in the centerline database. The crash mapping task was then performed in order to identify locations of crashes for analyzing patterns of those crashes.

After these mapping tasks, crash locations were identified accurately by overlaying the mapped crashes and construction project sites. An example outcome of this mapping process is illustrated in Figure 2.

Figure 2. An Example of Crash and Construction-Project Mapping

IV. DATA ANALYSIS

The collected project data were analyzed based on project information such as work type, size, and location. The research team categorized two groups, time-related incentive projects and non-incentive projects, in order to test any differences with regard to the occurrence of crashes. First, the research team performed data-mapping processes for analysis. Second, the occurrence of crashes for both groups, time-related incentive projects and non-incentive projects were investigated using three different time frames: 1) Before Construction, 2) During Construction, and 3) After Construction. Statistical analyses were then performed to test any differences with regard to the occurrence of crashes.

CRASH DATA AGGREGATION FOR CONSTRUCTION ZONES

Crash data can be collected before, during, and after highway construction projects in a project location, and variations of crash frequency should be studied to measure the safety impact. Therefore, it is important to accurately count the number of crashes that occurred for three time frames; before, during, and after highway construction projects. In order to achieve this task, the research team conducted the following subtasks:

- Identification of locations of highway construction zones,
- Identification of crashes that occurred within highway construction zones, and
- Aggregation of crash counts by three time frames.

It is also important to utilize spatial and temporal information from a variety of data sources, including the national highway dataset, California Highway Patrol's crash data, and highway construction data.

CONSTRUCTION WORK-ZONE LOCATION IDENTIFICATION

The first step of this project was to convert textual location of highway construction zone to spatial data using GIS. In other words, this task was to identify the spatial locations of highway construction zones collected as a tabular format on a map. This task was also necessary to spatially associate the construction zones with the locations of crashes later.

In order to accomplish this task, location information of highway construction zones was extracted. Location information typically consists of highway number, mile posts, and textual description of construction projects.

Utilizing a highway number and mile posts, it was feasible to locate construction zones on the National Highway Planning Network (NHPN) from the National Transportation Atlas Databases (NTAD). Since the NHPN data contains highway number and beginning and ending mile posts for each highway segment, the researchers were able to match the location information of construction zones with NHPN as shown in Figure 3. This task required a manual operation, since there is no method that automatically matches two different sets of location information.

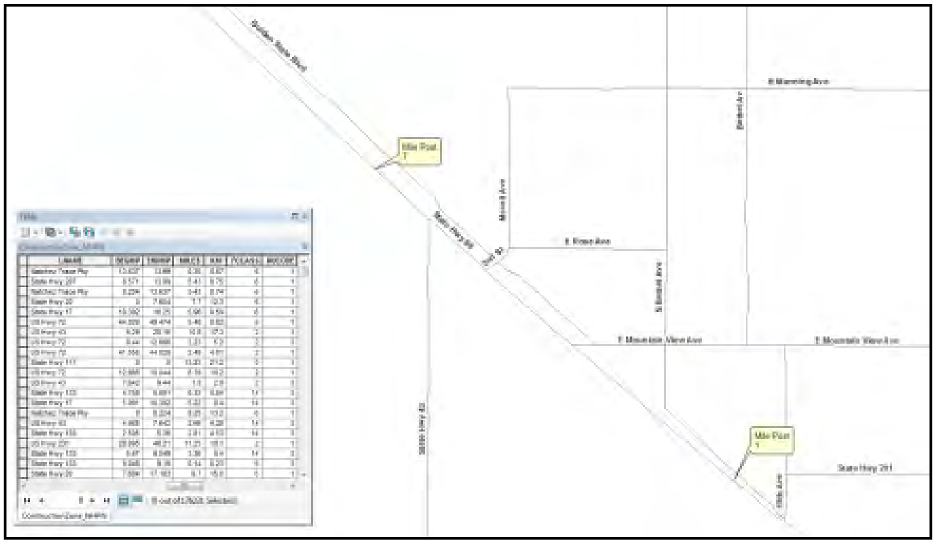

Figure 3. Locating a Construction Zone on NHPN

The identified location of each construction zone was confirmed with the location description from the construction zone data. The description includes street names adjacent to construction zones. The location of the construction zone was double-checked by comparing the street names from the description to the street names on the Environmental Systems Research Institute (ESRI) World Street Map as shown in Figure 4.

Figure 4. Construction Zone Confirmation with World Street Map

After confirming the location of the construction zone with ESRI's World Street Map, the construction zone was finally depicted on the map. This task made it possible for the research team to construct a spatial data set for the construction zone as shown in Figure 5.

Figure 5. Spatial Data of Construction Zone

IDENTIFICATOIN OF CRASHES

The research team identified crashes that occurred within highway construction zones using crash data from 2002 to 2011 collected from the Statewide Integrated Traffic Records System, which is a means to collect and process data gathered from a collision scene by the California Highway Patrol (CHP). The crash data was overlaid on the construction zone data created from the previous step as shown in Figure 6.

In this case, a ½ mile buffer for the construction zone was applied in order to select crashes occurred within the construction zone and under the influence of the construction zone in Figure 7. However, selected crashes include not only crashes that occurred on the highway where the construction was implemented, but also ones along surrounding streets. Only the crashes that occurred on the highway of construction were sorted out by addition spatial analysis and data query analysis in Figure 8.

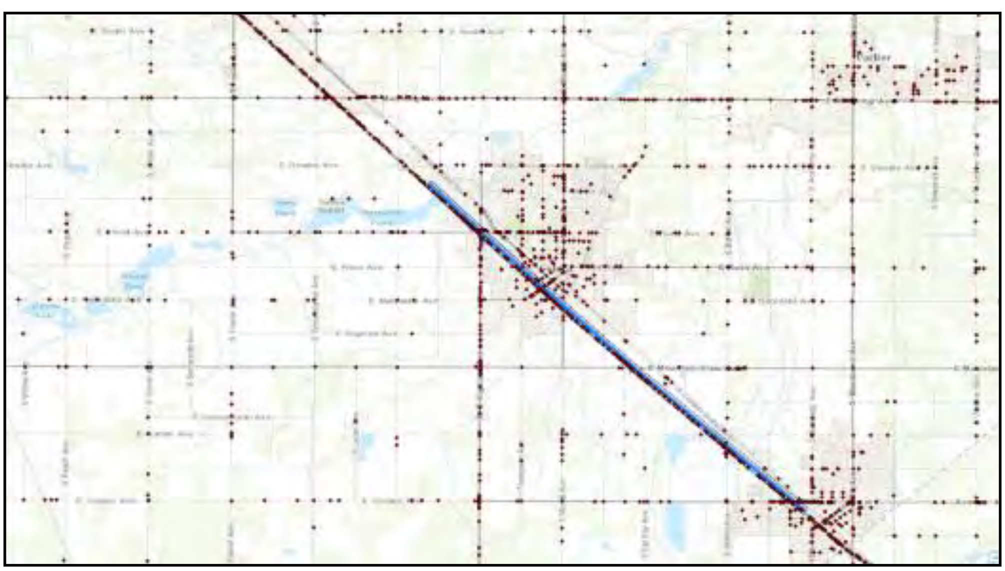

Figure 6. Crashes Over a Construction Zone

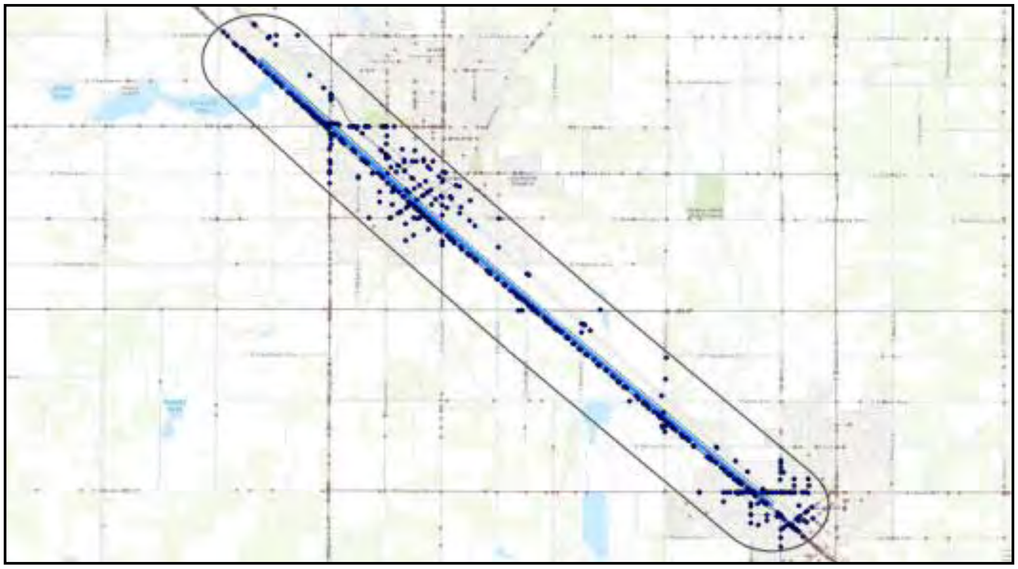

Figure 7. Buffer Analysis on Crashes

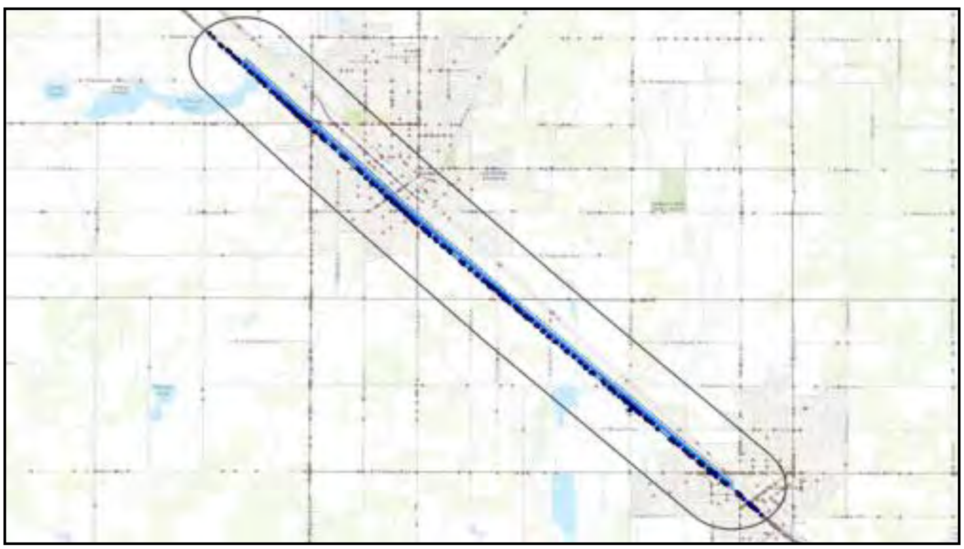

Figure 8. Crashes on the Highway Undergoing Construction

AGGREGATION OF CRASH COUNTS BY THREE TIME FRAMES

The construction zone data provides the time frame of construction including work start date and construction acceptance date. The crash data also contains the dates of incidents. Therefore, it was possible to group the crashes within a construction zone by three time frames, before, during, and after construction throughout data query analysis as shown in Figure 9.

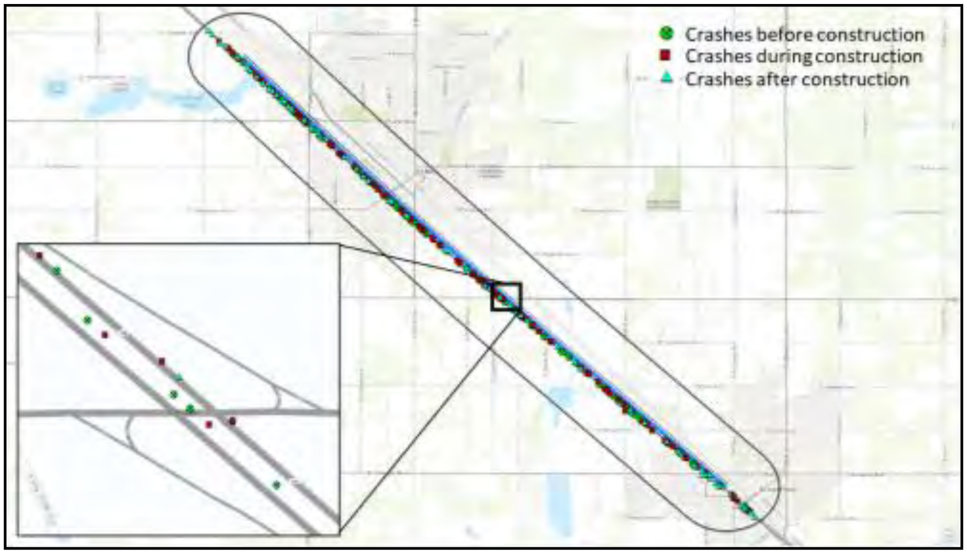

Figure 9. Crashes by Three Time Frames

CRASH COMPARISON AND STATISTICAL ANALYSIS

Based on the output from mapping tasks, the research team was able to aggregate the numbers and characteristics of crashes by construction project area. Construction projects were classified into two main categories, time-related incentive projects and non-incentive projects. Occurrence of crashes before, during, and after time-related incentive project construction was graphically compared in Figure 10. Occurrence of crashes before, during, and after non-incentive project construction was graphically compared in Figure 11. In both figures, the numbers of crashes in some projects were significantly different before, during, and after construction. It was necessary to perform a further analysis to test if the differences were statistically significant. A series of statistical analyses were then performed to find any differences between the two groups, time-related incentive projects and non-incentive projects, with regard to the occurrence of crashes.

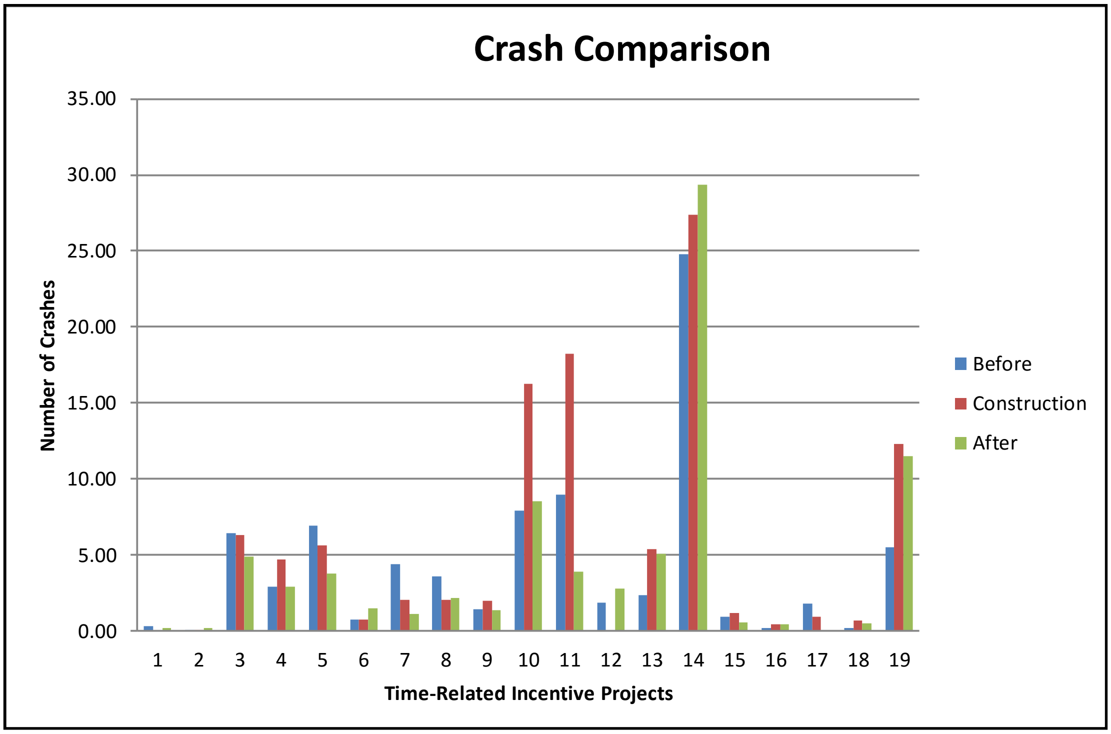

Figure 10. Crash Comparison for Time-Related Incentive Projects

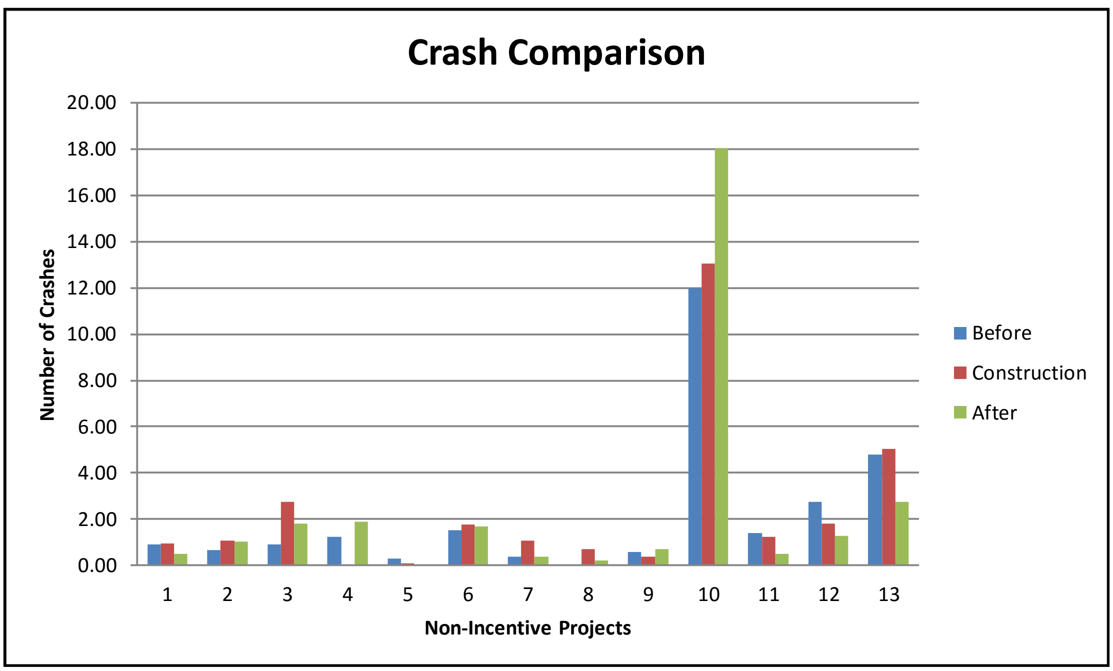

Figure 11. Crash Comparison for Non-Incentive Projects

An analysis of variance (ANOVA) test for time-related incentive projects was performed to test if the occurrence of crashes is significantly different among three scenarios: 1) Before Construction, 2) During Construction, and 3) After Construction. Summary Statistics of three variables for time-related incentive projects were shown in Table 1. The *F*-test results for time-related incentive projects are shown in Table 2.

Table 1. Summary Statistics of Variables for Incentive Projects

Groups	Count	Sum	Average	Variance
Before	19	81.3	4.3	32.5
Construction	19	106.3	5.6	57.9
After	19	80.7	4.2	46.1

The statistical analysis results for time-related incentive projects show that the difference of crash occurrence among all three variables — before construction, during construction, and after construction are not significant. The statistical significance of the variance is given by the probability value (*p*-value) defined in this study to be significant when it is smaller than 0.05. Since the *p*-value (0.783) is much greater than 0.05, we cannot conclude from this test that the effect of the three variables is significant. This indicates that there is no adverse safety impact on time-related incentive contracting projects during the study period.

Table 2. ANOVA Table for Crash Effect for Incentive Projects

Source of Variation	SS	df	MS	F	P-value
Between Groups	22.5	2	11.258	0.247	0.782
Within Groups	2,457.6	54	45.510		
Total	2,480.1	56			

An ANOVA test for non-incentive projects was performed to test if the occurrence of crashes is significantly different among three scenarios: 1) Before Construction, 2) During Construction, and 3) After Construction. Summary Statistics of three variables for non-incentive projects are shown in Table 3. The *F*-test results for time-related incentive projects are shown in Table 4.

Table 3. Summary Statistics of Variables for Non-Incentive Projects

Groups	Count	Sum	Average	Variance
Before	13	27.4	2.1	10.4
Construction	13	29.8	2.3	12.2
After	13	30.7	2.4	22.8

The statistical analysis results for non-incentive projects show that the difference of crash occurrence among all three variables Before Construction, During Construction, and After Construction are not significant. The statistical significance of the variance is given by the probability value (*p*-value) defined in this study to be significant when it is smaller than 0.05. Since the *p*-value (0.985) is much greater than 0.05, we cannot conclude from this test that the effect of the three variables is significant. This indicates that there is no adverse safety impact on non-incentive contracting projects during the study period.

Table 4. ANOVA Table for Crash Effect for Non-Incentive Projects

Source of Variation	SS	df	MS	F	P-value
Between Groups	0.448	2	0.224	0.015	0.985
Within Groups	545.8	36	15.161		
Total	546.3	38			

V. CONCLUSIONS AND RECOMMENDATIONS

The research team successfully compiled data representing the locations of construction work zones and crashes using GIS technology and performed statistical analyses to compare the frequency of crashes at time-related incentive construction project sites before, during, and after construction. The methodology used for this study to find a relationship between time-related incentive road construction projects and the frequency of vehicle crashes seems to be effective.

An ANOVA test for both time-related incentive projects and non-incentive projects was performed to test if the occurrence of crashes is significantly different among three scenarios: 1) Before Construction, 2) During Construction, and 3) After Construction. The statistical analysis results for both projects show that the difference of crash occurrence among all three variables are not significant. This indicates that there is no adverse safety impact on time-related incentive contracting projects during the study period. No statistical evidence was found that time-related incentive contracting projects have a negative impact on work-zone safety performance.

Although there was no work-zone safety difference among three scenarios, it is noted that the number of project data used for this study was small and limited. Only 19 time-related incentive projects and 13 non-incentive projects were collected and tested for this study. Therefore, in order to draw more meaningful conclusions, it is necessary for the research team to collect more project data for each project type category and perform a statistical analysis with a large sample size such as 30 or more projects for each project type category.

APPENDIX A – INCENTIVE PROJECTS

Project ID	Project Location (District)	Project Type (Construction)	Original Contract Amount (USD)	Project Construction Duration (Days)	Final Project Acceptance Date
Incentive #01	08	CHIP SEAL	$181,900	20	7/15/2003
Incentive #02	07	CONSTRUCT APPROACH SLAB	$231,500	227	11/3/2004
Incentive #03	10	CONSTRUCT FREEWAY AND BRIDGES	$74,350,000	93	4/4/2008
Incentive #04	01	CURVE IMPROVEMENT	$2,196,000	37	9/17/2009
Incentive #05	04	EMERGENCY BRIDGE REPAIR	$19,750,000	33	6/19/2007
Incentive #06	04	INSTALL ELECTRICAL SUBMARINE CABLE	$11,538,340	562	11/19/2007
Incentive #07	07	REALIGN AND WIDEN EXISTING HIGHWAY	$27,058,000	601	10/9/2008
Incentive #08	02	RECONSTRUCT INTERCHANGE	$4,528,000	409	5/24/2010
Incentive #09	08	RECONSTRUCT TIMBER RETAINING WALL	$1,826,000	127	4/8/2003
Incentive #10	07	REHABILITATE PAVEMENT	$79,350,000	509	3/27/2009
Incentive #11	07	REPAIR FIRE DAMAGE TO TRUCK TUNNEL	$20,000,000	1,130	11/16/2007
Incentive #12	03	REPLACE BRIDGE DECK	$2,797,000	355	11/6/2008
Incentive #13	07	ROADWAY AND BRIDGE REHABILITATION	$8,404,200	238	12/16/2004
Incentive #14	04	SEISMIC RETROFIT	$214,640,000	995	4/8/2009
Incentive #15	06	WIDEN AND REHABILITATE FREEWAY	$61,890,000	86	2/27/2008
Incentive #16	07	WIDEN EXISTING FREEWAY	$36,310,000	73	7/30/2008
Incentive #17	07	WIDEN OFF RAMP	$10,535,000	341	6/1/2010
Incentive #18	02	WIDEN ROADWAY AND BRIDGES	$115,000,000	605	7/1/2005
Incentive #19	05	WIDEN TO 6 LANES	$47,720,000	830	10/30/2008

APPENDIX B – NON-INCENTIVE PROJECTS

Project ID	Project Location (District)	Project Type (Construction)	Original Contract Amount (USD)	Project Construction Duration (Days)	Final Project Acceptance Date
Non-Incentive #01	10	CHIP SEAL	$201,800	7	8/10/2004
Non-Incentive #02	02	CONSTRUCT ACCESS ROAD	$171,700	25	10/18/2005
Non-Incentive #03	01	CONSTRUCT ASPHALT CONCRETE	$1,420,500	91	12/5/2005
Non-Incentive #04	01	CURVE REALIGNMENT	$2,072,000	125	12/16/2005
Non-Incentive #05	07	RECONSTRUCT INTERCHANGE	$17,650,000	900	6/27/2006
Non-Incentive #06	06	REPLACE BRIDGE DECK	$2,261,000	202	2/16/2005
Non-Incentive #07	03	ROADWAY AND BRIDGE REHABILITATION	$8,792,000	491	6/22/2005
Non-Incentive #08	04	STORM DAMAGE REPAIR	$1,709,000	90	6/30/2004
Non-Incentive #09	06	WIDEN AND RESURFACE ROADWAY	$9,062,000	115	1/17/2007
Non-Incentive #10	03	WIDEN EXISTING FREEWAY	$36,160,000	522	5/27/2005
Non-Incentive #11	08	WIDEN OFF RAMP	$691,700	281	12/19/2005
Non-Incentive #12	08	WIDEN ROADWAY	$41,480,000	344	1/3/2008
Non-Incentive #13	07	WIDEN ROADWAY AND BRIDGES	$83,710,000	1,242	11/1/2007

ABBREVIATIONS AND ACRONYMS

A+B	Cost plus Time
ANOVA	Analysis of Variance
Cal Poly Pomona	California State Polytechnic University, Pomona
Caltrans	California Department of Transportation
CHP	California Highway Patrol
ESRI	Environmental Systems Research Institute
FHWA	Federal Highway Administration
GIS	Geographic Information System
I/D	Incentive/Disincentive
MTI	Mineta Transportation Institute
NCHRP	National Cooperative Highway Research Program
NHPN	National Highway Planning Network
NTAD	National Transportation Atlas Databases
SJSU	San José State University
STAs	State Transportation Agencies
SWITRS	Statewide Integrated Traffic Records System

ENDNOTES

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