Use of Incentive/Disincentive Contracting to Mitigate Work-Zone Traffic Impacts

Final Report
November 2012

SWZDI
Smart Work Zone Deployment Initiative

Mizzou
University of Missouri - Columbia

Sponsored by
Smart Work Zone Deployment Initiative
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(InTrans Project 06-277)

About SWZDI

Iowa, Kansas, Missouri, and Nebraska created the Midwest States Smart Work Zone Deployment Initiative (SWZDI) in 1999 and Wisconsin joined in 2001. Through this pooled-fund study, researchers investigate better ways of controlling traffic through work zones. Their goal is to improve the safety and efficiency of traffic operations and highway work.

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The mission of the Institute for Transportation (InTrans) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, reliability, and sustainability while improving the learning environment of students, faculty, and staff in transportation-related fields.

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16. Abstract

Incentive/disincentive clauses (I/D) are designed to award payments to contractors if they complete work ahead of schedule and to deduct payments if they exceed the completion time. A previously unanswered question is, "Did the costs of the actual work zone impacts that were avoided justify the incentives paid?" This report answers that question affirmatively based on an evaluation of 20 I/D projects in Missouri from 2008 to 2011. Road user costs (RUC) were used to quantify work zone impacts and included travel delays, vehicle operating costs, and crash costs. These were computed using work zone traffic conditions for partial-closure projects and detour volumes and routes for full-closure projects. Conditions during construction were compared to after construction. Crash costs were computed using Highway Safety Manual methodology. Safety Performance Functions produced annual crash frequencies that were translated into crash cost savings. In considering an average project, the percentage of RUC savings was around 13% of the total contract amount, or $444,389 of $3,464,620. The net RUC savings produced was around $7.2 million after subtracting the approximately $1.7 million paid in incentives. In other words, for every dollar paid in incentives, approximately 5.3 dollars of RUC savings resulted. I/D provisions were very successful in saving RUC for projects with full-closure, projects in urban areas, and emergency projects. Rural, non-emergency projects successfully saved RUC but not at the same level as other projects. The I/D contracts were also compared to all Missouri Department of Transportation contracts for the same time period. The results show that I/D projects had a higher on-time completion percentage and a higher number of bids per call than average projects. But I/D projects resulted in 4.52% higher deviation from programmed costs and possibly more changes made after the award. A survey of state transportation departments and contractors showed that both agreed to the same issues that affect the success of I/D contracts. Legal analysis suggests that liquidated damages is preferred to disincentives, since enforceability of disincentives may be an issue. Overall, in terms of work zone impact mitigation, I/D contracts are very effective at a relatively low cost.

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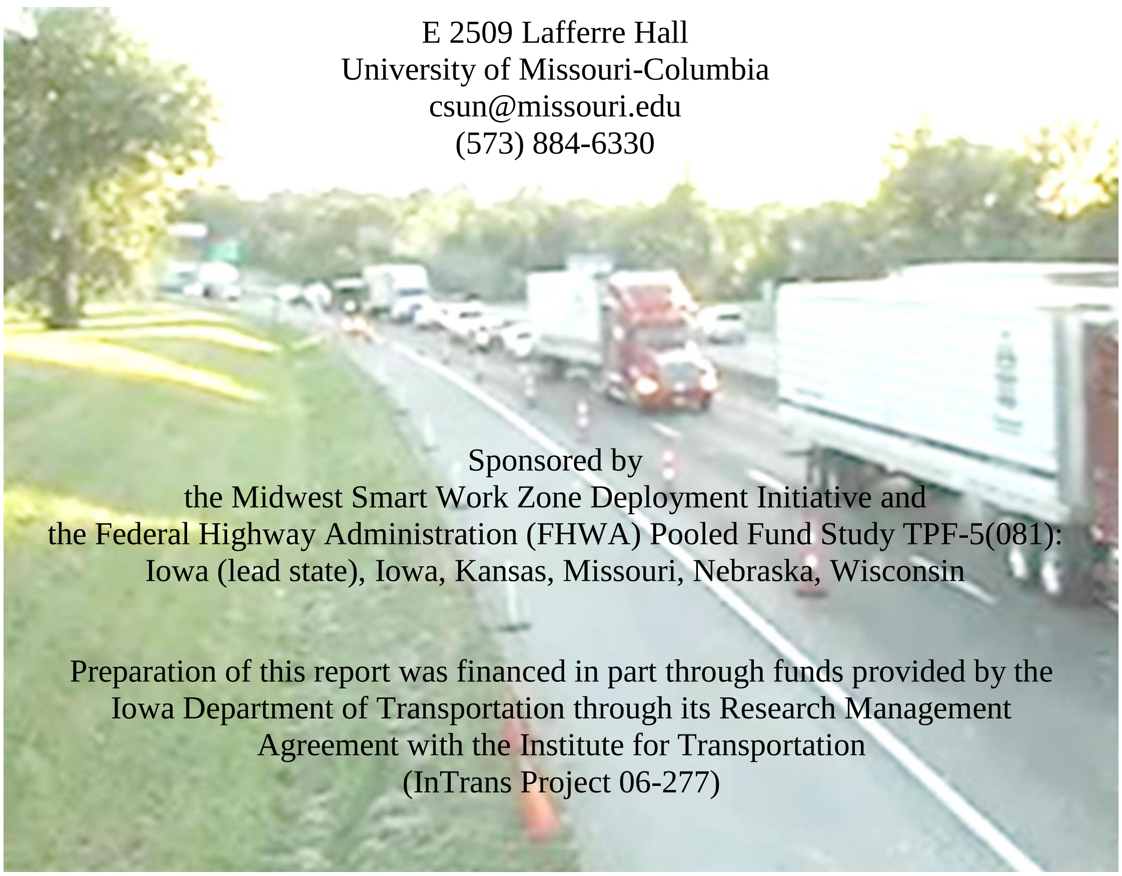

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EXECUTIVE SUMMARY

Incentive/disincentive clauses (I/D) help to accelerate highway construction by awarding payments if work is completed ahead of schedule and deducting payments if the completion time is exceeded. Even though there have been many recent studies on this topic, including NCHRP 652, the one important question still left unanswered is, “Did the costs of the actual work zone impacts that were avoided justify the incentives paid?” All I/D projects in Missouri from 2008 to 2011 were examined and the results show that I/D was highly effective in mitigating work zone impacts. Twenty I/D projects were examined in detail. Work zone impacts in terms of road user costs (RUC) were computed separately for three categories: traveler delay costs, vehicle operating costs and safety/crash costs. For both partial and full closure work zones, the impacts of detours were analyzed. Traveler delays were computed using well-known Highway Capacity Manual (HCM) analysis. Delays were valued separately for passenger cars and commercial trucks. The vehicle operating costs includes items such as fuel and wear and tear of vehicles. The safety costs were calculated using Highway Safety Manual (HSM) analysis. HSM methodology involved the prediction of crash frequencies using safety performance functions and crash modification factors reflecting length and duration of work zones.

Table A shows summary statistics for I/D project in Missouri. Out of a possible 278 incentive days, 214 days were reduced through incentives. The RUC savings from those 214 days amounted to approximately $8.9 million. The net RUC savings produced was around $7.2 million after subtracting the approximately $1.7 million paid in incentives. In other words, for every dollar paid in incentives, approximately 5.3 dollars of RUC savings resulted. On average, the RUC saved was $444,389 of $3,464,620 or around 13% of the average contract amount. The average and median incentive rates were $7655 per day and $4357 per day, respectively. The average I/D rate was set at 16.7% of the daily RUC. None of the 20 I/D projects resulted in disincentives being assessed. This asymmetry in incentives being awarded much more then disincentives being assessed is also found in the experiences of other states.

Table A I/D Project Summary, 2008-2011

No.	Max Poss. Inc. Days	Days Saved	Daily RUC	RUC Savings	Incentive Paid	Net RUC Savings
Total	278	214		$8,887,783	$1,684,000	$7,203,783
Target (day of max incentive)	278	278	N/A	$11,493,358	$2,351,680	$9,141,678
Percent	100	64		77%	72%	79%
Average	14	11	$48,799	$444,389	$84,200	$360,189
Median	9	7	$31,008	$140,123	$30,500	$69,816

The I/D projects were cross-tabulated into the categories of full-closure, urban, rural and emergency projects. In terms of net RUC savings, the most effective were emergency projects

(93%) followed closely by full closures (86%) and urban projects (80%). Rural, non-emergency projects produced the smallest net percentage of RUC savings at 33%. But even in rural, non-emergency projects, the RUC savings exceeded the incentives paid. This rural result is due to the small amount of traffic in rural areas and a larger incentive amount with respect to RUC. The percentages of I/D as a proportion of RUC were 36.4% for rural, non-emergency; 24.1% for urban, 12.1% for full closure; and 8.0% for emergency projects.

In addition to the analysis of individual projects, a programmatic comparison between I/D projects and all MoDOT projects was conducted. One measure of performance is the percentage deviation of the final cost from the programmed cost. On average, I/D project deviated more at -11.82% as compared to other projects at -7.30%. A related measure is the percentage difference between the original award and the total construction payouts. For I/D projects, this difference ranged between 0.3% and 6.5% annually, while overall projects ranged between 0.4% and 1.9% annually. It appears that I/D projects are programmed more conservatively, and they are subject to a greater percentage change from the original award. In terms on-time performance, I/D projects performed better than other projects. On an annual basis, 83% to 100% of I/D projects were completed on-time compared to 67% to 79% for all projects. For I/D projects, the average number of bids per call is actually higher than other projects. Thus the demands of project acceleration do not reduce competition in the current economic climate.

Twenty-eight DOT responses and twenty-one contractor responses were received for surveys on I/D experience. In general, the survey responses from DOT and contractors were very similar. The survey results indicate that I/D provision are used by almost all DOTs with a few incorporating I/D contracting into their standard procedures. DOT and contractors both responded that the top issues in a successful I/D project are well-defined project scope, timely problem resolution, communications with the contractor and preconstruction planning. A flexible start date is the least important. The DOT indicate that the two most influential project characteristics for motivating the use of I/D are high traffic volume facilities and the potential for severe traffic disruptions. Most DOT do not require a specific project characteristic for I/D to be used. How I/D rates are set varies significantly among the DOT. The quantitative amount ranges between 10% and 100% of the RUC. DOT and contractors agree that a poorly defined project scope, plans and specification errors and utility conflicts are significant challenges to using I/D. Neither group believes that worker morale is a significant challenge to I/D. As is evidenced by actual project data, the surveys also agreed that I/D provisions do effectively motivate construction acceleration. Despite the general similarities between DOT and contractor responses, one exception is the question on the possibility of increasing the number of incentive days. It appears that contractors are more confident in their ability to further accelerate projects. The bid amounts on I/D projects do not appear to be higher or lower than other projects.

The use of incentive/disincentive clauses in transportation is heavily influenced by §635.127 of Title 23 of the Code of Federal Regulations. The intended effect of this regulation is to facilitate the inclusion of road user costs (RUC) to accelerate projects. However, one possible unintended consequence is for disincentives to be construed as unenforceable penalties as illustrated in *Milton*. This report argues for an alternate approach to disincentives where liquidated damages include all reasonable foreseeable damages including RUC. The reasons for this approach are to prevent RUC from being construed as impermissible security for performance, to avoid double counting RUC, and to reflect the asymmetry in the legal principles justifying disincentives as opposed to incentives. This approach lets the liquidated damages amount speak for itself: on high traffic impact projects, the RUC amounts will naturally be high and on low traffic impact projects the RUC amounts will be negligible. In addition to the aforementioned legal issues, DOT often need to consider other issues such as public perception of incentives.

1. INTRODUCTION

As cities and urban highways become more congested each year, the timely or accelerated completion of transportation projects gains greater importance in contracting. A summary of several studies indicates that approximately 50% of all highway congestion is non-recurring due to work zones, incidents, weather and special events (Chin et al. 2002). Approximately 83% of congestion occurs on urban freeways and 15% on rural freeways. Thus departments of transportations (DOT), being owners of such facilities, face increasing pressure to minimize work zone impacts. Several contracting procedures seek to reduce traffic impacts by reducing the time traffic is exposed to work zones through the use of incentive/disincentive (I/D) contract provisions (AASHTO 2001). The Code of Federal Regulations (2012) defines an incentive/disincentive for early completion as "a contract provision which compensates the contractor a certain amount of money for each day identified critical work is completed ahead of schedule and assesses a deduction for each day the contractor overruns the incentive/disincentive time." However, there has been little effort on the DOT to investigate the effectiveness of such contract provisions for mitigating work zone impacts.

The motivation behind the decision to use I/D contracts is to reduce the construction schedule on projects that cause significant work zone traffic impacts. The level of impact is measured by road user costs (RUC), namely the increase in RUC due to a highway construction project. As such, I/D contracts are typically reserved for projects with high RUC impacts and the incentive and disincentive amounts are calculated based on this increased RUC (FHWA, 1989). RUC, for the purpose of setting I/D amounts, are determined by costs associated with the increased delay and safety risks that drivers experience within work zones and/or the additional costs of using a detour route. In cases where the work requires a detour, the RUC is based on the additional time and distance driven on the detour route. This additional travel distance not only causes delays but also an increase in vehicle operating costs and the probability for crashes.

An additional consideration when using a schedule-based incentive contract is the contractor's increased cost due to the acceleration of construction. These costs are difficult to accurately estimate because every contractor has different capabilities for acceleration. When setting I/D rates, the amount must be higher than the acceleration costs for the contractor or there will be no reduction in the schedule or impacts to the public. The reduction in construction time from a successfully executed I/D contract will benefit both the contractor and the traveling public at a minimal cost to the DOT.

This research aims to answers the question, "Did the costs of the actual impacts that were avoided justify the incentives paid or did the costs that were incurred justify the disincentives that were assessed?" It is not enough to say that since the I/D rate was set lower than the RUC then the I/D will benefit the public favorably. There is a tradeoff between ratio of the I/D rate to the RUC and the amount of schedule compression. If the I/D rate to RUC ratio is conservative, i.e. the I/D rate is set relatively low, then the contractor may not be motivated to reduce the schedule. On the other hand, if the ratio is set too generously, i.e. the I/D rate is set relatively high, the public will benefit less favorably from the compressed schedule. The optimal ratio of I/D rate to RUC exists somewhere in-between the extremes, but there is currently no widely acceptable way to determine this optimal ratio. To examine how current practices of I/D contracts are performing in these regards, highway construction projects with I/D provisions from the state of Missouri were evaluated.

1.1. Research Objectives

To validate the motivations for using an accelerating contracting technique like I/D, projects were evaluated to determine the amount of RUC actually avoided. When deciding to use an I/D contract, DOT officials are motivated by the potential benefits to road users versus how much it will cost to achieve an accelerated schedule. These benefits to road users involve a reduction in the work zone traffic impacts including delay time, vehicle operating costs, and safety. The net benefit will be the difference in avoided RUC and the incentives paid. Aside from the direct costs of paying contractor incentives, there are other potential effects for which the costs are not easily determined. Previous studies have indicated potential issues to be higher bid amounts, difficulty with staying within budget, and overestimated contract times resulting in unnecessary incentive payments (Gillespie 1998). Nearly every highway construction project causes some amount of increased RUC. Although some research has suggested that all projects should have some form of I/D to account for the RUC (Bajari and Lewis 2009), FHWA (1989) advises to reserve I/D provisions for projects with significant impacts on RUC. Therefore, projects that are appropriate for I/D use will have RUC that are significantly higher than the amount needed to motivate the contractor to accelerate construction. In other words, a successful I/D contract will achieve an accelerated schedule by paying an incentive that is justifiably lower than the RUC. The best way to determine if I/D provisions are effective is to evaluate completed I/D contracts. If schedule reductions were achieved and considerable net RUC savings were realized, then the incentive was justified. The first part of this study evaluated 20 MoDOT I/D contracts and determined if the RUC savings justified the incentives paid.

To seek out potential issues with I/D contracts, the second part of this study compared the performance of various administrative issues of I/D contracts to the average contract let by MoDOT. Contract administration could be affected by the inclusion of an I/D provision into a contract. As part of MoDOT's ongoing report on its performance, the quarterly Tracker document, it keeps a record of contract performance. The specific performance measures that were used were completion time performance, percent change in the contract amount after construction, number of bids per contract, and contract budget. If I/D contracts are performing as expected then I/D contracts should be completed earlier than average. The percentage change in the contract amount was evaluated because a large change can quickly erode the effectiveness of I/D contracts (Fick et al. 2010). A high number of bids indicates a competitive market, which can benefit the DOT with possible lower award amounts (Fick et al. 2010). Finally, since the amount of incentives paid or disincentives received is not known until contract completion, budgeting for I/D contracts is challenging. This study will use these measures to evaluate how I/D contracts performed with respect to the typical contract.

I/D contracts have other variables that affect the success of accelerating construction. Issues involving planning, communication, and project development were explored. A survey of DOT and contractors was used to determine what issues are the most important to each party. This survey supplements the other findings in this study with qualitative measures.

1.2. CONTRIBUTION TO THE STATE OF THE ART

This research began with a literature review of previous evaluations of I/D contracts. These evaluations can be categorized into quantitative project analysis, case studies and survey-based analysis. The quantitative analysis involved the examination of quantitative performance measures. It was found that there has been no systematic analysis of I/D projects for investigating work zone traffic safety and mobility impacts in previous studies. Some quantitative analyses performed have involved small sample sizes of four to six projects. Most of these studies have emphasized project management issues and not work zone impacts. Case studies involved the examination of a specific project. Even though these individual studies were detailed, the studies differed greatly with each other, thus no useful comparisons could be made. The survey-based analysis involved the examination of general perspectives and attitudes towards I/D. The surveys lacked quantifiable information about the impacts of I/D contracts on work zone traffic impacts.

Overall, the literature shows that no significant attempt has been made to evaluate the effectiveness of I/D contracts on mitigating work zone traffic impacts. In particular, there has been no evaluation of a state's completed use of I/D contracting over a period of time. This research showed just how much RUC can be saved with the proper use of I/D contracts by a DOT. Other DOT can use this research to evaluate their use of I/D contracts and compare their experience with Missouri's. This could result in constructive collaboration between states to further increase the effectiveness of I/D contracts in the future.

Previous evaluations of I/D contracts have typically been limited to single case studies, small sample sizes of projects, or a comparison of multiple types of alternative contracting. This research offers a large sample size of twenty projects that represent almost the complete use of I/D projects by MoDOT over a four-year span. This also resulted in an evaluation of the programmatic use of I/D contracts by a DOT. This type of evaluation was done by comparing I/D contracts to the average performance of all MoDOT contracts. This opened the door for continuous tracking of I/D contracts so DOT employees can easily observe how I/D contracts are performing over time. By doing this, it will become easier to make improvements to the I/D contracting process, justify further use, or even restrict use if certain I/D contracts are used inefficiently.

2. Literature Review of I/D Project Evaluations

Through their experience, the researchers in the NCHRP 652 report stated that meaningful quantitative data such as project duration, relative cost comparisons, I/Ds paid or charged were limited (Fick et al. 2010). The primary factor for determining whether an I/D contract was effective was whether the contractor was able to meet the I/D milestone and was paid an incentive for early completion. The items that had the greatest potential to erode the effectiveness of I/D provisions were the frequency and impact of excusable delays and overrun and underrun quantities. The report also stated that existing literature lacked quantitative data and analysis. This lack of quantitative project analysis of I/D projects is one central motivation for this research.

A recent National Bureau of Economic Research publication discussed the results of quantitative analysis of 490 sample highway construction projects from Minnesota (2006). But this project focused on lane rental projects only and did not evaluate any I/D projects. The authors perform a simple delay analysis using Google Maps on a subset of 99 projects, but no meaningful traffic analysis is conducted.

Strong (2006) evaluated design-build, lane-rental and A+B (cost + time) contracting methods by considering administration costs, project costs, management complexity, disruption to third parties, RUC, innovation, product/process quality, and funding flexibility. Their methodology used both a survey of national experts and a review of projects. The reviewed projects included three A+B, one lane rental and one design-build. The three A+B and one lane rental projects were analyzed through a cost comparison of the following: first cost, final cost, bid durations, final durations, and approximate internal administrative costs as function of total project cost. The authors cautioned the reader about the significance of the results because of the small sample size of four projects. The authors also raised the issue that the effects of incentive clauses were difficult to separate from the effects of A+B contracting.

The Minnesota Department of Transportation (Mn/DOT) (2006) examined six I/D projects between 2000 and 2005 with two of them involving liquidated savings. For each project, Mn/DOT examined the engineer estimates, low bid, maximum incentive amounts and the amount of incentives paid. For the incentive projects, Mn/DOT stated that contractors used extra effort to complete projects early in order to obtain bonuses, which strained Mn/DOT oversight staff. But there was not enough data to determine if contractors were adjusting bids in anticipation of obtaining bonuses to offset costs. The contractors did not appear to expedite construction for liquidated savings projects.

State’s uses of I/D provisions have shown to effectively reduce the time frame of construction projects that have a serious impact on traffic. Arditi et al. (1997) studied a number of projects for the Illinois Department of Transportation and found that 93.3% of projects that used I/D provisions finished on time or ahead of schedule compared to 41.4% that did not use I/D provisions.

Even though previous case studies provided detailed examples of I/D projects, it was difficult to compare the studies with each other in order to derive general conclusions. Some case studies involved California freeways such as I-15 (Lee and Thomas 2007) and I-710 (Lee et al. 2006). Another study was of I-95 in Delaware (FHWA 2004). For some of these studies, the authors performed traffic impact assessment of the project by monitoring closures and comparing the closure traffic with historical traffic data from the same location. Thus the authors sought to investigate whether the accelerated rehabilitation project resulted in tolerable traffic impact, but the authors did not seek to examine whether the incentive amounts earned corresponded to the traffic and safety impacts avoided. Such issues were not the focus of previous case studies, but are the main focus of the current report.

In terms of survey-based methods for evaluating I/D contracts, the NCHRP project on I/D obtained surveys from thirty-two states and in-depth investigations of six states (Fick et al. 2010). In terms of safety, the authors discussed the significant challenges that exist in evaluating the safety impacts of I/D contracts. The authors even claimed that in their judgment, it was nearly impossible to conduct a safety comparison between contracts that incorporate acceleration clauses and those that do not. And no one interviewed was aware of any attempt to conduct such an analysis. Further, the chapter entitled, “Evaluating I/D Effectiveness”, only discusses the need for adequate metrics to be developed for I/D effectiveness evaluation. This study again validates the need for conducting research on evaluating I/D projects using quantifiable metrics.

Other survey-based studies examined I/D contracts together with A+B. One study concluded that A+B project increased bid price by 7.5% when compared with non-I/D projects (Strong et al. 2005). Gillespie (1998) suggests that acceleration provisions, especially when combined with A+B bidding, tend to produce more innovative bids from contractors in order to compete in the bidding market and have the opportunity to earn the maximum incentive. A drawback to I/D provisions is that bid prices could rise due to the increased risk transferred to the contractor. As shown by Arditi et al. (1997), most I/D projects pay incentives, and the final cost of the project could be unnecessarily high if a completion date is too generous. In conclusion, even though there is a significant collection of I/D literature, there has not been a study that directly linked incentive/disincentives to a reduction in work zone traffic impacts.

3. BACKGROUND OF I/D CONTRACTING

3.1. PROJECT SELECTION

The FHWA (1989) stresses that I/D provisions should be restricted to critical projects where it is essential to keep user delays and traffic impacts to a minimum. Highway construction projects are all unique, and I/D may not be appropriate for all cases. I/D provisions are typically used in order to accomplish the objectives of reducing contract duration, completing construction before a special event, or to limit capacity impacts for high traffic flow areas (Cackler, 2010). Other objectives are also evaluated on a case-by-case basis. One major factor in deciding when to use I/D is high RUC that must be reduced. The FHWA (2006) has recommended the following characteristics in deciding when to use an I/D provision:

- Projects on high traffic volume facilities, generally in urban areas
- Projects that will complete a gap in a significant highway system
- Major reconstruction or rehabilitation on an existing facility that will severely disrupt traffic
- Major bridges out of service
- Projects with lengthy detours

3.2. ESTABLISHING CONTRACT TIME

According to the FHWA (1989) the contract duration can be based on past performance or the critical path method (CPM). The past performance method requires engineering judgment to determine the normal completion time of a project based on historical data and also the amount of time it is possible to compress the schedule with increased labor and resources. The CPM method breaks the project into the individual components and bases the duration on what stages are critical to complete in order to move on to the next. Additional resources can be incorporated into the various stages in order to determine the possible compressed schedule. The contract time determination is a crucial component to I/D provisions. If the time is too short, contractors may feel it will be impossible for them to complete the work on time and therefore not bid on the project. If the time is too long, the contractor could complete the work without increased effort and the incentive goal for the DOT will not be maximized.

3.3. RUC AND I/D

According to the FHWA (1989), the determination of I/D amounts should be based on established construction engineering inspection costs, state related traffic control and maintenance costs, detour costs, and road user costs. Administrative costs such as construction inspection and state related costs are commonly covered in separate liquidated damages clauses and thus not always included into I/D amounts. The determination of I/D amounts should be on project-by-project bases and can be adjusted downward if necessary by using engineering judgment. The setting of the I/D amount from the RUC should provide a favorable benefit/cost ratio to the traveling public while also providing enough motivation to the contractor to accelerate construction. One report to the FHWA presents the components of RUC as travel delay costs, vehicle operating costs, crash costs, emissions costs, and impacts of nearby projects (Mallela and Sadasivam 2011). One NCHRP report says that most states include only travel delay costs and vehicle operating costs in RUC calculations because these components are usually high enough to justify the use of an I/D (Fick et al. 2010).

Once the RUC is determined then the daily rate can be set at any value at or lower than the RUC (Fick et al. 2010). Careful consideration is used to balance the number of incentive days and I/D rate, which are inversely proportional when there is a maximum incentive amount as discussed below. Mallela and Sadasivam (2011) suggest using a discount factor ranging from 0.2 to 1.0 of the RUC to set the I/D rate. This decision is based on factors such as market conditions, confidence in RUC estimates, work zone factors, and importance of early completion. The most aggressive discount factor would equate to the I/D rate being set just above the contractor's acceleration costs.

3.4. Setting Maximum I/D Amounts

The FHWA (1989) recommends a maximum amount of incentive payments be set in order to protect a DOT in cases where the estimated project time was too generous. A suggested cap of 5% of the total project cost is recommended but different states have set their own caps. Table 3-1 shows various caps for maximum incentives. The maximum incentive may also be determined based on the remaining budget for a project (Fick et al. 2010).

Table 3-1 DOT Cap Rates (Gao 2010)

State	Cap
Alabama	None
Arizona	±30days
Arkansas	None
California	Dollar Amount*
Colorado	None
Delaware	None
Florida	Varies
Georgia	None
Idaho	Varies
Illinois	None
Indiana	Dollar Amount***
Iowa	None
Kansas	Dollar Amount*
Maine	Dollar Amount***
Maryland	5%
Massachusetts	None
Michigan	5%
Minnesota	None
Missouri	10%
Montana	Varies
Nevada	Varies
New Hampshire	None
New Jersey	Dollars 100,000
New York	10%
North Carolina	Varies
North Dakota	5%
Ohio	5%
Pennsylvania	5%
South Dakota	None
Tennessee	None
Utah	Dollar Amount***
Virginia	Dollar Amount**
Washington	5%
Wisconsin	Varies
Wyoming	6-8%

*Fixed
**Fixed except the A+B contracts
***Fixed or negotiated not available

An alternative approach to fixed cap rates is a regression model that was developed by Chen and Shr (2004) to establish maximum incentive amounts. This model used historical data of I/D contracts in Florida. The model equation is simple to use and is able to estimate the maximum incentive or maximum number of incentive days based on the contract amount and contract time. Because only contracts from Florida were used, the model would have to be calibrated for each state.

3.5. CONSIDERING CONTRACTOR ACCELERATION COSTS

Chen et al. (2004) showed that contractor acceleration costs (CAC) increases exponentially the more the construction schedule is compressed. The knowledge of the CAC when determining appropriate I/D amounts is necessary so that the daily rate is set high enough to motivate the contractor's acceleration efforts. In order to compress a construction schedule, a contractor must use additional resources, extended workdays, and/or additional shifts. Figure 3-1 illustrates this relationship as the construction time is decreased the cost to the contractor increases. The difficulty for DOT and researchers in understanding CAC is the lack of data from contractors. CAC information is proprietary and affects a contractors competitiveness.

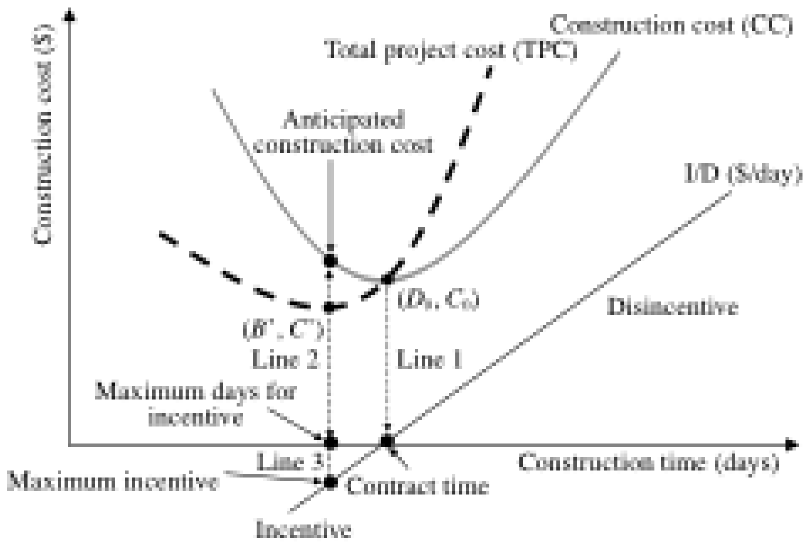

Figure 3-1 Determination of I/D amounts with CAC (Chen et al. 2004)

Choi, Kwak, and Yu (2010) used a similar method to develop a regression equation based on the increased cost of construction compared to the amount of possible schedule compression for various resource levels. They used data obtained from the CA4PRS software. CA4PRS estimates construction schedules based on various rehabilitation strategies and contractor's resource levels. The software estimates project costs and RUC. The methodology employed by Choi et al. (2010) was to incrementally increase the resource levels of four historical road rehabilitation projects in California and plot the increased cost versus the reduction in the projects duration. With this data, they were able to fit a quadratic equation to model the relationship. By finding the first order derivative of this equation, the maximum reduction of schedule as determined by a DOT could be entered to get the daily increase of construction costs experienced by the contractor.

3.6. MODOT'S USE OF I/D CONTRACTING

MoDOT uses I/D provisions to encourage early completion of construction projects. According to MoDOT's Engineering Policy Guide (EPG) 237.8.6, *Liquidated Savings Specified/Liquidated Damages Specified* is the job special provision (JSP) used as the I/D provision in their contracts. The term *disincentive* is not used but *Liquidated Damages Specified* is used instead. Also there is careful mention in the EPG not to doubly assess damages if typical liquidated damages are used along with I/D provisions. These features of the MoDOT JSP matches closely the legal recommendations described in the chapter on legal analysis of incentive/disincentive contracts. The exact language used in the EPG describing the JSP shown below, and the actual JSP is reproduced in Appendix B.

237.8.6 Liquidated Savings Specified/Liquidated Damages Specified

This is a job special provision that encourages early completion of a project or phase of a project by offering an incentive while limiting construction time by assessing a liquidated damage specified. This provision is similar to A+B bidding except MoDOT sets the time. If the contractor finishes the described work ahead of time, the contractor receives an incentive. If the contractor finishes the described work after the time set, contractor is assessed a liquidated damage specified. If the time set is for project completion, the liquidated damage specified is not to be applied in addition to regular liquidated damages for the same costs (double assessment). The potential incentive amount is to be factored into the project budget as soon as possible.

Suggested criteria for use:

- Completion of milestones are critical to future work
- There is a critical completion date
- Long detours
- Public or worker safety
- Contract time is lengthy or short

4. DATA COLLECTION

Construction Project data used in this study was obtained through MoDOT's databases. Data from twenty I/D projects from the year 2008 to 2011 was utilized in this report. MoDOT contracts with I/D provisions include the Job Special Provision (JSP), *Liquidated Damages/Liquidated Savings Specified*. This JSP explicitly states that amounts received or charged for completion time are based on costs to the traveling public. The full JSP is available in Appendix B.

MoDOT has used various forms of contracting to accelerate construction but only I/D projects were specifically considered in this study. Contracts with A+B bidding were not included. This study focuses on the effectiveness of the contract itself and not the bidding process. Evaluation of the bidding process (e.g. A+B bidding) could necessitate unavailable contractor information.

A total of twenty-seven contracts with the I/D JSP were found in MoDOT's database. Of those contracts, only twenty-one had the necessary data for this analysis. One of those twenty-one contracts was excluded because it was structured as a "lump-sum bonus" contract. It was also apparent that the lump-sum incentive was incorporated to motivate the contractor to finish construction before the weekend of a home University of Missouri football game. Because of this unique situation and the "lump-sum bonus" clause, it was decided to leave out this contract. Details on the twenty projects used in this study are shown in Table 4-1.

Table 4-1 I/D Project Details

No.	Contract Days	Original Contract Amount	Description of Work	AADT of Work Zone	Incentive Period	I/D Rate	Max Incentive Allowed	Max Incentive Days
ID01	220	$588,464.00	Bridge rehabilitation	1,970	14	$2,000	$10,000	5
ID02	54	$3,492,032.80	Emergency flood repair, roadway scour	1,858	34	$8,000	$80,000	10
ID03	73	$2,633,985.63	Emergency flood repair, roadway scour	1,008	60	$3,000	$15,000	5
ID04	25	$3,293,570.90	Emergency flood repair, roadway scour	1,858	25	$10,000	$100,000	10
ID05	31	$1,290,131.07	Emergency flood repair, roadway scour	9,520	7	$12,000	$36,000	3
ID06	180	$2,129,437.87	Bridge replacement	14,300	127	$15,000	$225,000	15
ID07	93	$2,097,000.00	Emergency bridge rehabilitation	1,975	46	$10,000	$100,000	10
ID08	78	$483,025.24	Bridge replacement	17,191	42	$5,000	$70,000	14
ID09	260	$6,795,644.83	Intersection improvement	35,000	242	$10,000	$70,000	7
ID10	297	$514,588.43	Bridge resurfacing	2,580	4	$3,840	$7,680	2
ID11	236	$13,705,018.30	Grading, optional pavement	9,960	175	$15,000	$300,000	20
ID12	273	$2,881,819.99	Bridge rehab & bike/ped path	30,000	135	$9,000	$156,000	18
ID13	103	$574,492.26	Bridge rehabilitation	486	85	$2,000	$60,000	30
ID14	205	$2,650,395.06	Resurfacing	2,560	12	$2,000	$10,000	5
ID15	759	$14,838,238.82	Bridge replacement	1,470	365	$7,000	$504,000	72
ID16	118	$559,158.73	Replace concrete pavement	16,760	17	$15,000	$25,000	1.667
ID17	40	$331,913.90	Slide repair	10,692	23	$5,000	$25,000	5
ID18	46	$104,681.15	Pipe replacement	20,283	14	$2,000	$10,000	5
ID19	135	$1,064,668.53	Bridge rehabilitation	1,600	117	$13,000	$100,000	8
ID20	234	$9,264,133.39	Bridge replacement	29,500	$90	$14,000	$448,000	32
Ave.	173	$3,464,620	N/A	10529	82	$8,142	$117,584	14
Med.	127	$2,113,219		6050	44	$8,500	$70,000	9
Max.	759	$14,838,239		35000	365	$15,000	$504,000	72
Min.	25	$104,681		486	4	$2,000	$7,680	2

On average, contract days were around 173 days. The average contract amount was approximately three and a half million per contract. The average I/D rate was around $8,000/day. The maximum incentive averaged almost $120,000, and the average maximum number of incentives days was 14 days. The I/D contracts in Table 4-1 covered a broad range. The largest number of contract days was 759 and the shortest was 25. The largest project amount was almost $15 million while the smallest was around $105,000. The I/D rate varied from $2000/day to $15,000/day.

The I/D projects used in this study were spread across the state and involved a variety of different types of road construction. Of the twenty projects, eleven were in rural areas and nine were in urban areas. The urban projects were located mostly in the Kansas City and St. Louis metro areas with one also in Jefferson City. There were five emergency construction projects, four due to massive flooding in Northeast Missouri in 2011 and another due to flood damage to a bridge in 2010. Nine projects involved bridge rehabilitation or replacement. Full closure of a roadway segment or road access existed on eighteen of the twenty projects with fifteen of those involving only a full closure. Three projects had intersection connection access closures and two projects involved only partial closure or lane reduction. The location of the twenty projects can be seen in Figure 4-1.

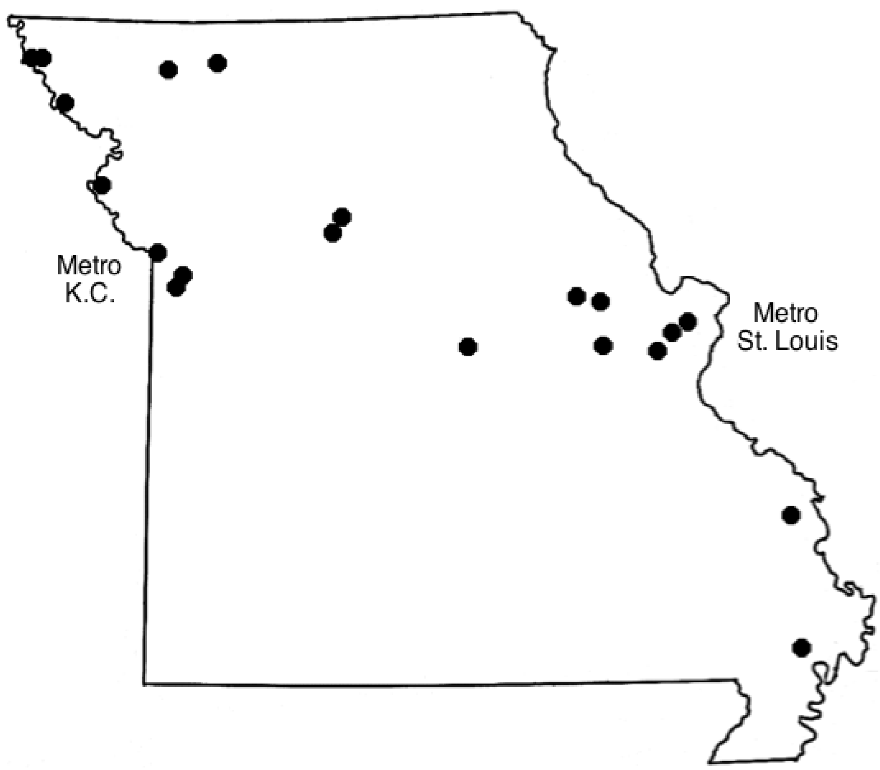

Figure 4-1 I/D Project Locations

For nine of the projects, the I/D was for the completion of a certain milestone of the construction. These projects included multiple phases or jobs and will be further classified only by the phase of construction that the I/D applied to. For example, a project with an I/D milestone involving reopening a rehabilitated bridge will be classified as full closure even if there was a non-I/D, partial-closure phase before or after closing the bridge. For eight of the remaining eleven projects, the I/D period started when work started and finished when the road opened to traffic. Any remaining work was not included in the I/D as long as there was no need for any special traffic control. The final three contracts had I/D provisions that required entire project completion. All of the contracts had an I/D structure of either a specific completion date or a number of calendar days, no contract specified working days. Most of the contracts had regular liquidated damages for completion of all contract work that could be applied separately. These liquidated damages are carefully calculated to not double assess the same damages according to MoDOT's EPG 237.8.6. Also, a few of the projects had separate liquidated damages specified or liquidated savings specified for different phases. These projects were typically the larger, more complex projects. For complete project details, see Appendix A.

5. WORK ZONE IMPACT METHODOLOGY

The primary way I/D contracts minimize work zone impacts is through schedule reductions. To show the impacts that a reduced schedule has on RUC, twenty MoDOT I/D projects were analyzed in detail. Typically, I/D rates are set as a percentage of the actual RUC. This insures that the traveling public receives a favorable cost/benefit ratio (FHWA 1989). In order to determine how much the schedule reduction benefitted the road users for each project, the RUC must be computed. For this analysis, three typical cost components were used to quantify RUC: travel-delay costs (TDC), vehicle-operating costs (VOC), and crash costs (CC). In other words:

$$RUC = TDC + VOC + CC \tag{5.1}$$

5.1. TRAVEL DELAY COSTS

TDC are the value of additional time incurred because of a work zone. For partial closure work zones, the MoDOT *Work Zone Impacts Analysis Spreadsheet* was used to calculate TDC (MoDOT, 2012a). This spreadsheet was developed based on the Highway Capacity Manual (TRB 2010) methodology. In the case of a detour caused by a full closure, travel delay is the difference between the time it takes to traverse the detour and the time it would have taken to use the normal route. The travel delay is then monetized by multiplying by the unit value of time (VOT) according to the equation below.

$$TDC\left(\frac{\$}{day}\right) = Delay * AADT * (VOT_{cars} * \%_{cars} + VOT_{trucks} * \%_{trucks}) \tag{5.2}$$

where:
DELAY = detour travel time – normal travel time, (hr/veh)
AADT = Annual average daily traffic of closed road (veh/day)
VOT_{cars} = Value of time for passenger cars, (\$/hr); \$10.30/hr
VOT_{trucks} = Value of time for trucks, (\$/hr); \$22.70/hr
$\%_{cars}$ = Percentage of AADT that is passenger cars (%)
$\%_{trucks}$ = Percentage of AADT that is trucks (%)

The difference in time from the normal route and the detour route was determined using travel distances and speed limits. The assumption that there were no significant congestion effects due to the additional traffic shifted from the closed routes was validated by the actual *AADT* values for each project. Contract plans for each project provided the AADT and the percent of trucks. The value of time for passenger cars and trucks were obtained from the MoDOT *Work Zone Impacts Analysis Spreadsheet* (MoDOT, 2012a).

For projects with partial closure or lane reductions, there is another component of TDC caused by the speed reduction through the work zone. Work zone speeds were found within the project plans. This component of TDC can be seen below.

$$TDC\left(\frac{\$}{day}\right) = AADT * \left(\frac{L}{S_{WZ}} - \frac{L}{S_N}\right) * (VOT_{cars} * \%_{cars} + VOT_{trucks} * \%_{trucks}) \tag{5.3}$$

where:
L = Length of the work zone (mi);
S_{WZ} = Work zone speed limit (mph);
S_N = Normal speed through the roadway segment (mph).

5.2. VEHICLE OPERATING COSTS

VOC are the mileage dependent expenditures generated by operating a vehicle. Cost items such as fuel use and vehicle wear and tear are included in VOC. For full closures, VOC are the additional costs due to the extra miles driven along the detour compared to the mileage of the normal route. The equation below shows how the VOC is calculated

$$VOC\left(\frac{\$}{day}\right) = MILES_{added} * AADT * \left(VOC_{cars} * \%_{cars} + VOC_{trucks} * \%_{trucks}\right) \tag{5.4}$$

where:
$MILES_{added}$ = length of detour – length of normal route, (miles/veh)
VOC_{cars} = unit VOC for passenger cars, (\$/mile); \$0.403/mile
VOC_{trucks} = unit VOC for trucks, (\$/mile); \$0.818/mile

The difference in mileage from the normal route and the detour route was determined using road maps. The unit VOC values were taken from AAA (2012) and Trego and Murray (2010) for passenger cars and trucks respectively.

5.3. CRASH COSTS

Crash costs for the various projects were calculated differently depending on the type of closure for the work zone. The method for calculating crash costs for the detour traffic is based on the Highway Safety Manual (HSM) (AASHTO 2010). For projects with partial-closure or lane-reduction work zones, a method from Khattak (2002) was used. Khattak's research was used in the HSM to calculate crash modification factors (CMF) for work zones. To determine crash costs with this method, the predicted number of crashes during the work zone is subtracted from the predicted number of crashes pre-work zone. This is done for both injury (including fatal crashes) and non-injury. A per-day cost is then calculated and added to the RUC. The equation below shows how crash costs for partial-closure and lane-reduction work zones are calculated.

$$Y = (x1)^{1.2659} * (x2)^{1.1149} * (x3)^{0.6718} * e^{-0.2257*x4} * e^{-0.5126*x5} * e^{0.1988*x6} * e^{-17.7748} \tag{5.5}$$

where:
Y = expected number of total crashes in a given duration on work zone segments;
x1 = average ADT of the work zone (vehicles per day);
x2 = duration of observation (days);
x3 = length of the work zones (km);
x4 = 1 if the roadway is in urban area; 0 otherwise;
x5 = 1 if injury producing crash; 0 otherwise;
x6 = 1 if crashes recorded during work zones; 0 otherwise (pre-work zone).

For projects with rural detours, the additional crash costs per day were calculated using chapter 10 of the HSM (AASHTO 2010). The risk of additional crash costs is due to the extra mileage driven by the detoured traffic. Equation 10.6 from the HSM predicts the additional crash frequency of the detoured AADT due to the additional mileage (L) of the detour. Using this calculated frequency, the predicted additional annual crashes can be found. HSM equation 10.6 is:

$$N_{spfrs} = AADT * L * 365 * 10^{-6} * e^{-0.312} \tag{5.6}$$

where:
$N_{spf\,rs}$ = predicted total crash frequency for roadway segment base conditions;
$AADT$ = detoured average annual daily traffic volume (vehicles per day);
L = additional detour length (miles)

For projects with urban detours the additional crash costs per day were calculated using chapter 12 of the HSM (AASHTO 2010). Five different crash types were calculated using this method from the HSM because of the unique characteristics of an urban setting. These crash types are multiple-vehicle non-driveway, single-vehicle, multiple-vehicle driveway-related, vehicle-pedestrian, and vehicle-bicycle. Variables needed to calculate crash costs along an urban roadway are type of roadway segment, number of driveways, and classification of those driveways. The HSM allows for varying levels of detail while calculating crash costs. The calculations for this analysis used the most common roadway type along the detour and an estimate, based on aerial maps, of the number and type of driveways along the detour. These variables were captured with regression coefficients in the HSM. This resulted in an approximate value of the crash costs along the detours appropriate enough for RUC calculations. Due to the unavailability of traffic counts for roadways intersecting with the detour, intersection crash counts were not calculated. The HSM provides a method of estimating intersection crash costs but because these roads are typically small roads owned by the city, the traffic counts were not available. It is thus assumed that crash costs included in the RUC are a conservative value and real crash costs may be higher. The following equations were used to calculate crash costs for urban detours.

Multiple-vehicle non-driveway:

$$N_{brmv} = e^{(a+b*\ln(AADT)+\ln(L))} \tag{5.7}$$

where:
N_{brmv}= number of multiple-vehicle non driveway collisions per year;
AADT = average annual daily traffic volume (vehicles/day) on roadway segment;
L = length of roadway segment (mi);
a, *b* = regression coefficients depending on roadway type.

Single vehicle:

$$N_{brsv} = e^{(a+b*\ln(AADT)+\ln(L))} \tag{5.8}$$

where:
N_{brsv}= number of single-vehicle collisions per year;
a, *b* = regression coefficients depending on roadway type.
Multiple-vehicle driveway-related:

$$N_{brdwy} = \sum_{\substack{all\\driveway\\types}} n_j * N_j * \left(\frac{AADT}{15{,}000}\right)^{(t)} \tag{5.9}$$

where:
N_{brdwy}= number of multiple-vehicle driveway-related collisions per year;
N_j = number of driveway-related collisions per driveway per year for driveway type *j;*
n_j = number of driveways within roadway segment of driveway type j including all driveways on both sides of the road;
t = coefficient for traffic volume adjustment.

Vehicle-pedestrian:

$$N_{pedr} = N_{br} * f_{pedr} \tag{5.10}$$

where:
N_{pedr} = Number of vehicle-pedestrian crashes
$N_{br} = N_{brmv} + N_{brsv} + N_{brdwy}$
f_{pedr} = pedestrian crash adjustment factor based on roadway type

Vehicle-bicycle:

$$N_{bike} = N_{br} * f_{bike} \tag{5.11}$$

where:
N_{bike} = Number of vehicle-bicycle crashes
f_{bike} = bicycle crash adjustment factor based on speed and roadway type.

The total crash cost can be found by adding up these five types of urban crashes. This is shown in the equation below. To calculate the added crash cost along the detour route, the crash cost from the normal route must be subtracted from the detour route.

$$N_{spfur} = N_{brmv} + N_{brsv} + N_{brdwy} + N_{pedr} + N_{bike} \tag{5.12}$$

A composite cost per crash was estimated using historic crash data from MoDOT and HSM (ASSHTO 2010) methodology. All work zone crashes from 2009 to 2011 were classified by severity. The 6749 total work zone crashes were composed of 2.70% fatal, 0.52% disabling, 21.11% evident injury and 75.67% PDO crashes. According to HSM methodology, all crash costs were adjusted to 2011 values. The human costs were adjusted using the Consumer Price Index and the non-human societal costs were adjusted using the Employment Cost Index from the Bureau of Labor Statistics. The unit crash cost of a work zone crash in Missouri in 2011 was \$172,221. The crash cost, *CC*, is estimated using:

$$CC\left(\frac{\$}{day}\right) = \frac{N_{spf}}{365} * \$172{,}221 \tag{5.13}$$

where:
N_{spf} = predicted additional annual crashes, (crashes/year)

6. RESULTS

6.1. BREAKDOWN OF RUC COMPONENTS

For each of the twenty I/D projects used in this analysis, the RUC were calculated separately. Table 6-1 shows the breakdown of the three components used to calculate RUC: TDC, VOC and CC. On average, the VOC was the largest component equating to approximately 50% of the RUC. TDC was the next largest at 35% and CC only amounted to 15%. The two projects with no VOC were projects with only partial closures and thus no detour routes.

Table 6-1 RUC Components

No.	Daily TDC	Daily VOC	Daily CC	Daily RUC
ID01	$6,127	$9,368.71	$2,632.44	$18,129
ID02	$26,249	$48,619.22	$11,711.24	$86,580
ID03	$10,631	$20,048.21	$5,337.00	$36,016
ID04	$26,249	$48,619.22	$11,711.24	$86,580
ID05	$83,348	$157,298.96	$49,204.84	$289,851
ID06	$15,616	$11,513.29	$3,742	$30,871
ID07	$13,652	$18,865.94	$5,228.46	$37,747
ID08	$49,596	$42,791.84	$11,747	$104,134
ID09	$9,205	$12,147.00	$7,073	$28,425
ID10	$12,579	$15,226.02	$2,334	$30,139
ID11	$8,321	$980.00	$4,449.00	$13,750
ID12	$2,501	$0.00	$1,250.00	$3,751
ID13	$2,195	$2,649.92	$765.83	$5,611
ID14	$9,148	$17,473.00	$4,873.00	$31,494
ID15	$8,378	$18,171.49	$4,595.75	$31,145
ID16	$1,182	$0.00	$427.00	$1,609
ID17	$17,812	$11,952.96	$3,351	$33,116
ID18	$1,584	$1,728.00	$1,811	$5,123
ID19	$5,599	$5,455.58	$1,532.92	$12,587
ID20	$34,409	$39,705.53	$15,213	$89,328
Total	$344,381	$482,615	$148,990	$975,986
Average	$17,219	$24,131	$7,450	$48,799
% of RUC	35.29%	49.45%	15.27%	100.00%

6.2. RUC SAVINGS ANALYSIS

After evaluating twenty I/D projects, Table 6-2 shows RUC savings benefitted the traveling public favorably. For a contractor to start earning incentives, the closed road segment must be reopened to traffic. Seventeen of the twenty contractors were able to open the road early and earn incentives. The other three contractors finished on time but did not earn any incentives. No contractor was assessed disincentives for any project. In Table 6-2, the number of days the contractor was able to reduce from the incentive period is shown in the third column. The fourth and fifth columns show the calculated daily RUC and the total RUC saved because of the early completion. The net RUC savings is the incentives paid subtracted from the RUC savings.

Table 6-2 RUC Savings

No.	Max Poss. Inc. Days	Days Saved	Daily RUC	RUC Savings	Incentive Paid	Net RUC Savings
ID01	5	5	$18,129	$90,643	$10,000	$80,643
ID02	10	15	$86,580	$1,298,693	$80,000	$1,218,693
ID03	5	0	$36,016	$0	$0	$0
ID04	10	10	$86,580	$865,795	$100,000	$765,795
ID05	3	4	$289,851	$1,159,406	$36,000	$1,123,406
ID06	15	15	$30,871	$463,064	$225,000	$238,064
ID07	10	2	$37,747	$75,493	$20,000	$55,493
ID08	14	3	$104,134	$312,403	$15,000	$297,403
ID09	7	20	$28,425	$568,500	$70,000	$498,500
ID10	2	0	$30,139	$0	$0	$0
ID11	20	20	$13,750	$275,000	$300,000	-$25,000
ID12	18	21	$3,751	$78,771	$156,000	-$77,229
ID13	30	32	$5,611	$179,549	$60,000	$119,549
ID14	5	2	$31,494	$62,988	$4,000	$58,988
ID15	72	0	$31,145	$0	$0	$0
ID16	1.67	5.63	$1,609	$9,051	$25,000	-$15,949
ID17	5	14	$33,116	$463,626	$25,000	$438,626
ID18	5	5	$5,123	$25,615	$10,000	$15,615
ID19	8	8	$12,587	$100,698	$100,000	$698
ID20	32	32	$89,328	$2,858,487	$448,000	$2,410,487
Total	278	214	N/A	$8,887,783	$1,684,000	$7,203,783
Target (day of max incentive)	278	278		$11,493,358	$2,351,680	$9,141,678
Percent	100	64		77%	72%	79%
Average	14	11	$48,799	$444,389	$84,200	$360,189
Median	9	7	$31,008	$140,123	$30,500	$69,816

Table 6-2 shows the total impact from the 20 I/D projects as 214 days reduced, around $8.9 million in RUC saved, around $1.7 million in incentives paid, and around $7.2 million in net RUC saved. The acceleration of the projects also resulted in almost 9 million VMT (vehicle miles traveled) saved for detoured traffic. This was calculated by multiplying together AADT, mileage difference of detours, and days reduced. The incentives were paid out as follows: seven contractors finished exactly on the day in which the full incentive could be earned, seven contractors finished earlier than the maximum number of incentive days (earned maximum incentive), three contractors earned partial incentives, and three contractors finished at the original contract time. The row entitled "Target" represents the total amounts if all contractors finished on the day to earn maximum incentives and is used as a reference point for comparison. Note that this does not imply that meeting the maximum number of incentive days was the most important goal. Table 6-2 shows 77% of the contracted RUC savings were realized, 72% of contracted incentives were paid and 79% of the net savings were realized. It is arguable what the ideal percentages should be, but the values indicate that MoDOT received close to the upper limit of their expected results. The return on investment of $1.00 of incentives is $5.30 of RUC savings.

Seven projects finished earlier than the maximum incentive day. In these cases, the contractor did not earn additional incentive but further RUC were saved. The total additional days reduced was almost 37, which amounted to nearly $1.5 million in RUC. Therefore it is possible for the RUC savings and net RUC savings to be higher than the values in Table 6-2 for the target row.

6.3. Effects of Project Characteristics

Table 6-3 below shows how various characteristics can affect the outcome of I/D contracts. Of the twenty projects, eleven were rural which included five emergency projects. There were no urban emergency projects. Six rural, non-emergency projects were separated from the emergency projects because of the uniqueness of the emergency projects. These six projects included four bridge closures, an access-restricted intersection, and ramp closures at an interstate interchange. The five emergency projects were unique. Four involved reopening flooded roads that led to key crossings across the Missouri River. The other emergency project was the repair of a bridge from a separate flooding event. The fifth project was compounded by another bridge closure in the area. These projects led to considerably higher RUC due to extremely long detours. The fifteen full closure projects include five urban projects and ten of the eleven rural projects, including all five emergency projects. The urban projects include the five full-closure urban projects as well as two with access-restricted intersections and two with partial closure of the roadway.

Table 6-3 below shows that the rural, non-emergency projects resulted in the smallest savings and only netted about one-third of the actual RUC saved. Although not shown in Table 6-3, all of the projects combined netted 81% of RUC with a target of 80% (calculated from Table 6-2). Also, the rural, non-emergency projects reduced the fewest number of target days. The lower performance was partly due to the low average daily RUC of $18,786 (see Table 6-4 below). Because of this, the incentives were set closer to the actual RUC to motivate the contractor to accelerate construction. Proportionally, even at the target number of days, rural, non-emergency contracts paid the most incentives compared to the RUC savings. The fact that only 23% of the target RUC savings was realized indicates that rural projects may not be the most suitable for I/D provisions.

Table 6-3 RUC Savings by Project Characteristic

Characteristic	Projects (ID##)		Days Saved	RUC Savings	Incentive Paid	Net RUC Savings	Net % RUC Saved
Rural, Non-Emergency (6 projects)	01, 11, 13, 14, 15, 19	Total	67	$708,878	$474,000	$234,878	33%
		Target	140	$3,034,583	$984,000	$2,050,583	68%
		Percent	48%	23%	48%	11%	
Urban (9 projects)	06, 08, 09, 10, 12, 16, 17, 18, 20	Total	116	$4,779,518	$974,000	$3,805,518	80%
		Target	100	$5,300,082	$1,036,680	$4,263,402	80%
		Percent	116%	90%	94%	89%	
Full Closure (15 projects)	01, 02, 03, 04, 05, 06, 07, 08, 10, 13, 14, 15, 17, 19, 20	Total	142	$7,930,846	$1,123,000	$6,807,846	86%
		Target	226	$10,923,567	$1,790,680	$9,132,887	84%
		Percent	63%	73%	63%	75%	
Emergency (5 projects)	02, 03, 04, 05, 07	Total	31	$3,399,387	$236,000	$3,163,387	93%
		Target	38	$3,158,693	$331,000	$2,827,693	90%
		Percent	82%	108%	71%	112%	

Note: Projects may be included with one or more characteristic

The nine urban projects reduced 16 more days than the target. This is the result of four of the contracts finishing earlier than the maximum incentive day. Interestingly, these extra days did not result in total RUC savings higher than the total target RUC savings. This is due to projects, which did not finish beyond the target, having a greater influence on the RUC savings. The project with the highest RUC ($104,134/day) only reduced 3 of 14 possible days. Altogether, the urban projects netted 80% of the RUC saved which was the same as the target percentage. At 90% RUC savings, nearly the entire target RUC savings was realized which indicates the I/D was successful in accelerating construction for urban projects.

Three-quarters of the twenty projects used were full-closure projects. Because of the larger sample size, the results might be more reliable than the results for other subcategories of projects. These full-closure projects netted 86% of the RUC savings, which was a higher percentage than the target of 84%. A total of 142 days were reduced, which was 63% of the target number. Reducing the target number of days is beyond actual expectations for I/D projects so reducing 63% of the target days is considered a success. The 63% of days reduced along with 73% of the target RUC saved indicates that the I/D rate and the maximum I/D cap are being set at appropriate values, balancing the contractor’s ability to accelerate construction and the agency’s desire to minimize RUC.

The five emergency projects are the only subcategory to save more RUC than the target value. This occurred even though only 82% of the target days were reduced. Two projects that had the highest RUC finished ahead of the target causing the 108% RUC savings. The fact that 93% of the RUC savings was realize cannot be used to compare to the other project characteristics fairly because of the unique circumstances of emergency contracts. Nonetheless, all indications are that the inclusion of the I/D with these emergency contracts saved considerable RUC at a relatively low cost to MoDOT.

6.4. DISCOUNT OF RUC FOR I/D RATES

The literature showed that I/D rates are typically set from 20% to 100% of the RUC depending on acceleration goals and RUC calculation methods. The amount that the I/D rate is discounted from the RUC affects the contractor's motivation for acceleration and magnitude of achievable net RUC savings. Table 6-4 below shows that on average, MoDOT only sets the I/D rate at 16.7% of the RUC. Considering the findings earlier in this chapter, this suggests that RUC can be discounted significantly to set I/D amounts and still successfully accelerate the contractor's schedule. Table 6-4 also shows that MoDOT is capping the maximum incentive at an average of 3.4% of the contract amount. This was calculated by finding the percent of the maximum allowed incentive to the original contract amount. This is below the suggested cap of 5% by the FHWA (1989).

Table 6-4 Average Daily Rates

Division	Average I/D rate	Average Daily RUC	I/D % of RUC	Incentive Cap
Rural, non-emergency	$6,833	$18,786	36.4%	2.9%
Urban	$8,760	$36,277	24.1%	4.5%
Full closure	$7,456	$61,555	12.1%	4.0%
Emergency	$8,600	$107,355	8.0%	2.6%
All projects	$8,142	$48,799	16.7%	3.4%

6.5. SUMMARY OF MODOT'S I/D USE

- The total cost of all contracts was **$69,292,400.90**
- The total contract days was **3460**
- The number of critical I/D days was **1634**
- The percent of critical I/D days that an incentive could be earned was **17%**
- **13%** of critical I/D days were actually reduced
- **$8.9** million in RUC was saved or almost a half million dollars per contract
- Total incentives paid was around **$1.7 million**
- **7** projects finished earlier than the day to earn the maximum incentive
- **7** projects finished at the maximum incentive day
- **3** projects earned partial incentives
- **3** projects finished at the I/D deadline (no incentive earned)
- No contractor was charged a disincentive
- Average I/D rate was set at **16.7%** of the daily RUC
- The average incentive was capped at **3.4%** of the original contract amount

7. STATE PROGRAMMATIC EVALUATION

In addition to the analysis of individual projects in the previous section, a programmatic comparison between I/D projects and all MoDOT projects was also conducted. MoDOT publishes a quarterly Tracker report. The purpose of the Tracker is to measure the performance of tangible goals set by the agency. So far MoDOT has not published measures specifically for I/D contracts. The following measures, currently recorded in Tracker, are areas where I/D contract performance could be compared to other contracting methods. By including I/D performance measures into a results based data tracking system like MoDOT's Tracker, it would be possible to set and achieve goals based on the motivations behind using I/D contracts. The twenty I/D contracts will be evaluated to see if the use of I/D provisions is an effective contracting technique.

The data for the overall MoDOT construction program was obtained from the Tracker, while the I/D project data was computed using the data described in previous sections. The following four measures were used for programmatic analysis: the percentage deviation of programmed cost versus final cost, the percentage of projects completed on time, the percentage of contract change, and the number of bids per call.

7.1. BUDGETING FOR I/D CONTRACTS

The ability of a project to stay on budget is becoming more and more important as funding for transportation is becoming harder to come by. One way of measuring this ability is by tracking the percent of programmed cost as compared to the final cost. Estimates for programmed costs are done early in project development but are important because programmed costs are used to set the budget for all future projects. The MoDOT Tracker reports the programmed project cost as compared to the final project cost for this very reason. These costs include design, right of way purchases, utilities, construction, inspection, and other miscellaneous costs. Ideally, the deviation in programmed versus final cost should be 0%. Negative numbers indicate the final cost was lower than the programmed cost. Five out of the twenty I/D projects were not used for this measure due to the lack of data on program estimates. Four of those five projects were emergency flood repairs and thus were not programmed in advance. For the period between 2008 and 2011, the deviation in cost was -7.30% for MoDOT projects as a whole and -11.82% for I/D projects. The average I/D percentage deviation was almost 4.5% more than all of MoDOT's projects indicating, perhaps, that I/D projects had much greater uncertainty and required more conservative programmed costs. Maximum incentives were only 2.98% of programmed estimate or $2.10 million for these fifteen contracts. Therefore it was not just the difficulties of budgeting for unknown incentive payments that were to blame. Actual incentive payments were only 2.32% of final contract costs or $1.44 million. It could be possible that MoDOT assumed that the I/D provision would result in higher bids from contractors due to more risk transferred to the contractor.

7.2. Scheduling I/D Contracts

The ability of a project to stay on schedule is another important measure of programming performance. Figure 7-1 compares the on-time performance of I/D projects versus all projects for the years 2008 to 2011. Figure 7-1 shows both unadjusted and adjusted data. The adjusted data reflects actual contract changes negotiated between MoDOT and the contractor. The schedule for the I/D projects considers the entire contract time and not just the portion of the project that had I/Ds. The findings show that I/D projects were completed on-time 100% of the time while all projects ranged from 91% to 97% if adjustments were taken into account. For unadjusted values, I/D projects were completed 83% of the time in 2010 and 2011, but MoDOT's projects as a whole were completed 79% and 74% of the time.

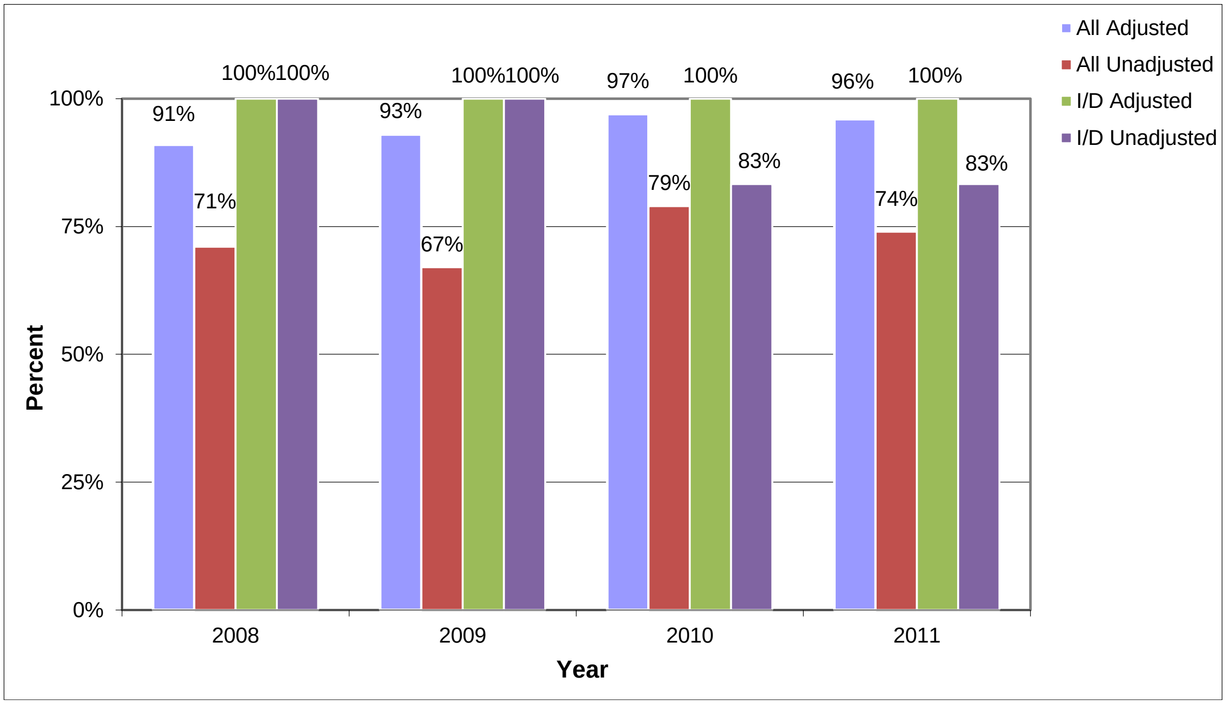

Figure 7-1 Percentage of Projects Completed on Time

7.3. I/D Contract Amount Changes

The percent change for finalized contracts represents the percentage difference of total construction payouts to the original award. This reflects changes made to the project after they were awarded to the contractor and does not include incentive payouts. Figure 7-2 shows percentage change for four years of I/D versus all MoDOT projects. Positive values reflect overruns while negative values reflect underruns. MoDOT had a target of keeping the percentage within ±2%. At first glance, I/D projects appear to require more changes. However, there were some outliers in the I/D data. The 2008 data was skewed by a project with a slope failure near the end of construction, and the 2011 data was skewed by an emergency contract with additional work added to the project after receding floodwaters showed more damage to the road than expected. When the outliers were removed, the *I/D Selected* data shows that I/D projects all fell within 2% of the original award.

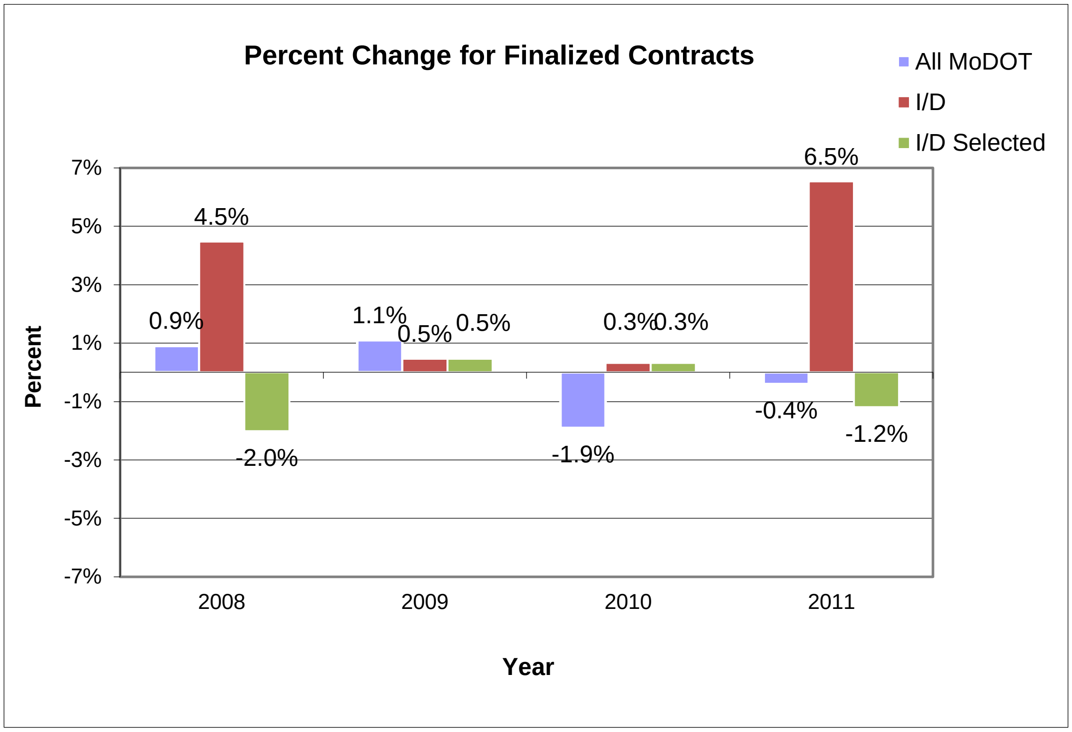

Figure 7-2 Percent Change in Finalized Contracts

7.4. Market Competition

One concern with I/D contracts is that the innovation required for accelerating projects might reduce the number of capable bidders. This is because acceleration could involve the use of multiple shifts, night shifts, newer technologies and flexible scheduling. This concern was not realized in actual project data. Figure 7-3 compares the average number of bids per call for all projects as compared to I/D projects. Except for 2010, there were more bids received per call for I/D projects than for all MoDOT projects. Assuming that all bidders were qualified to undertake accelerated projects, this result shows that the potential for incentive bonuses outweighed the complexity associated with acceleration.

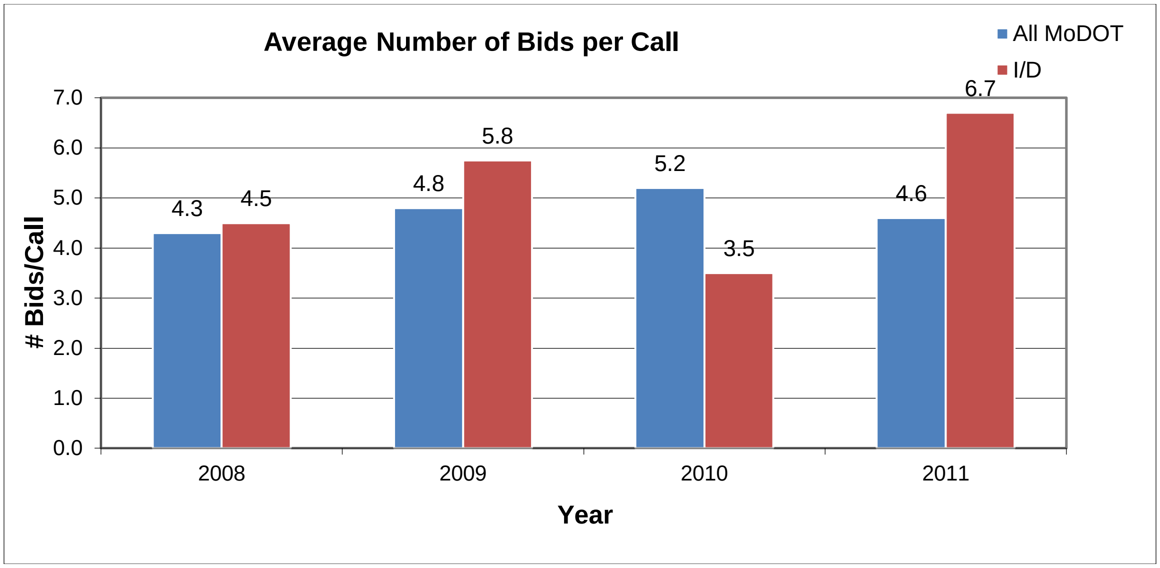

Figure 7-3 Average Number of Bids per Call

8. SURVEY OF I/D USE

As previously discussed in Chapter 2, NCHRP 652 was a recent project that examined I/D provisions in highway construction contracts (Fick et al., 2010). This project conducted in-depth DOT and contractor interviews from the states of Florida, Ohio, New York, California, Oklahoma and Utah. Since none of these states are in the SWZDI region, it was important to capture DOT and contractor perspectives from the state of Iowa, Kansas, Missouri, Nebraska and Wisconsin. The surveys employed in the current project differed from the NCHRP 652 surveys, as the focus of the current project is on work zone impacts.

Surveys were sent out to DOT and contractors to obtain their perspectives on I/D contracts. DOT contacts were identified by searching each state's website for personnel in various divisions such as contracting, alternative contracting, construction, and planning. A number of states did not list contact information for necessary personnel.

Seventy-one surveys were sent out to DOT employees in thirty-four states. This survey had thirty responses of which twenty-eight completed the survey. A total of twenty-two different states answered the survey. These states were Alaska, Arkansas, Delaware, Florida, Idaho, Indiana, Iowa, Kansas, Kentucky, Louisiana, Minnesota, Missouri, Montana, Nebraska, New Hampshire, North Carolina, Ohio, Oregon, Pennsylvania, Vermont, West Virginia and Wisconsin. Note that all SWZDI states responded to the survey.

Contractors were identified by using a list of prime contractors that are registered or have worked with MoDOT before. Many of these contractors are national or international companies, thus they would have experience working in multiple states. Contact information was identified using contractor websites. A total of 114 surveys were sent out to contractors and twenty-one responses were received. Seven additional contractors responded but did not fully complete the survey. Only eleven had experience with I/D contracts that finished the survey. The surveys instructed the responders to only consider contracts with I/D provisions and not A+B bidding. The respondents, both DOT employees and contractors, were both kept anonymous.

The surveys were primarily designed to capture qualitative measures and opinions of effective I/D contracts. The following survey results captures unquantifiable issues associated with pre-construction activities, during-construction activities, and unforeseeable circumstances. Various project issues were presented and respondents were asked how each contributed to the success of accelerating construction. These surveys were added to supplement the results of the I/D project evaluation because there are more factors affecting the success of schedule reduction than the amount of the I/D rate set by the DOT. Except for one respondent, everyone else (96.6%) replied that their DOT used I/D provisions to accelerate construction. One respondent said, "I/D is part of our Standard Specifications" and another said, "Innovative contracting is to be considered in every project but have had none in the past year."

In Figure 8-1 and Figure 8-2, DOT's and contractors were asked how each issue contributed to the success of accelerating construction. The top two issues that the DOT answered either *significantly* or *vey significantly* were “well-defined project scope” and “timely problem resolution”. This result is consistent with the literature. Changes in a project’s scope will almost always add time to a project. Also, a contractor will recognize if a project has a vague or poorly defined scope. This increases the risk to the contractor, and such risk will then be reflected in higher bids. Timely problem resolution is important for I/D projects since a significant amount of time-dependent money is at risk. MoDOT’s I/D JSP does not allow for adjustments on the incentive deadline but only for disincentives. Problems that the contractor has no control over could result in lost incentives. It is a positive sign for I/D contracts that the DOT recognize the importance of quick problem resolution.

The next two issues that DOT felt were important to the success of I/D contracts were “communication during construction with the contractor” and “Preconstruction planning”. Communication with the contractor is similar to timely problem resolution. Both issues keep the construction process running smoothly. Preconstruction planning helps to insure that the construction will stay on schedule and reduces the likelihood of problems arising. “Flexible start date” was the least important issue for the success of accelerating construction according to both DOT and contractors. The NCHRP 652 report found that I/D contracts tend to have more bidders if there was a flexible start date (Fick et al 2010). This increases the competitiveness of the market, which could result in a lower contract award amount. This implies that a flexible start date has more influence on the price paid for acceleration and not the acceleration itself. The responses from the DOT survey are highly supported by the contractor’s responses. For the four issues that were most important to the DOT, all of the contractors answered that the issues were either significant or very significant to the acceleration of construction.

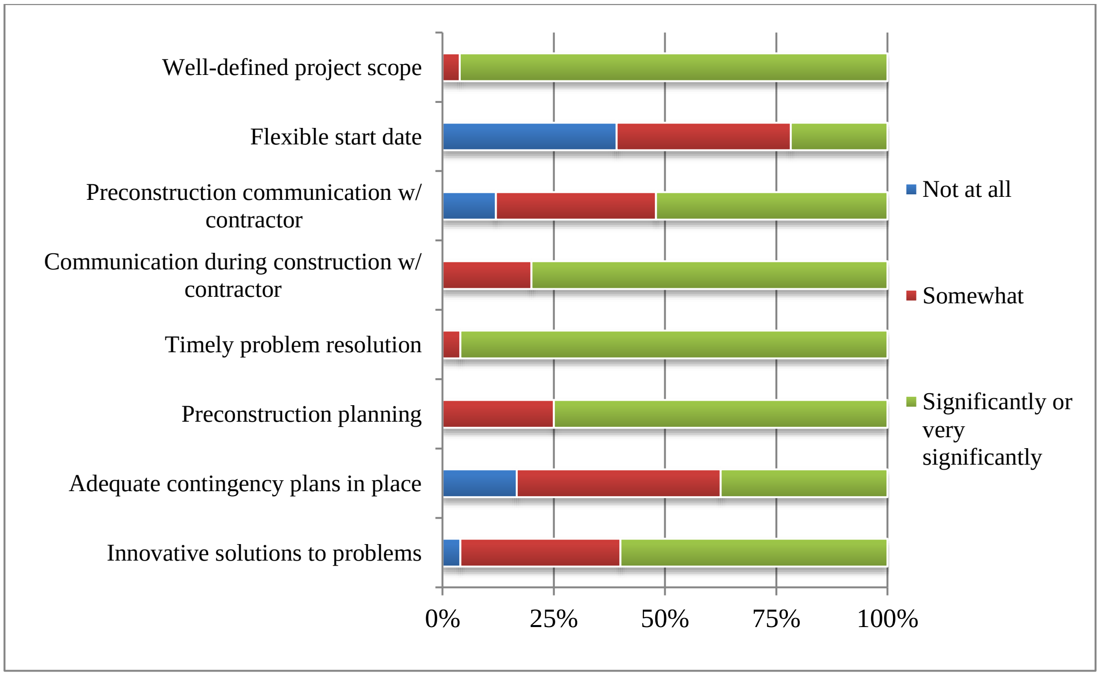

Figure 8-1 DOT Responses to Acceleration Success Issues

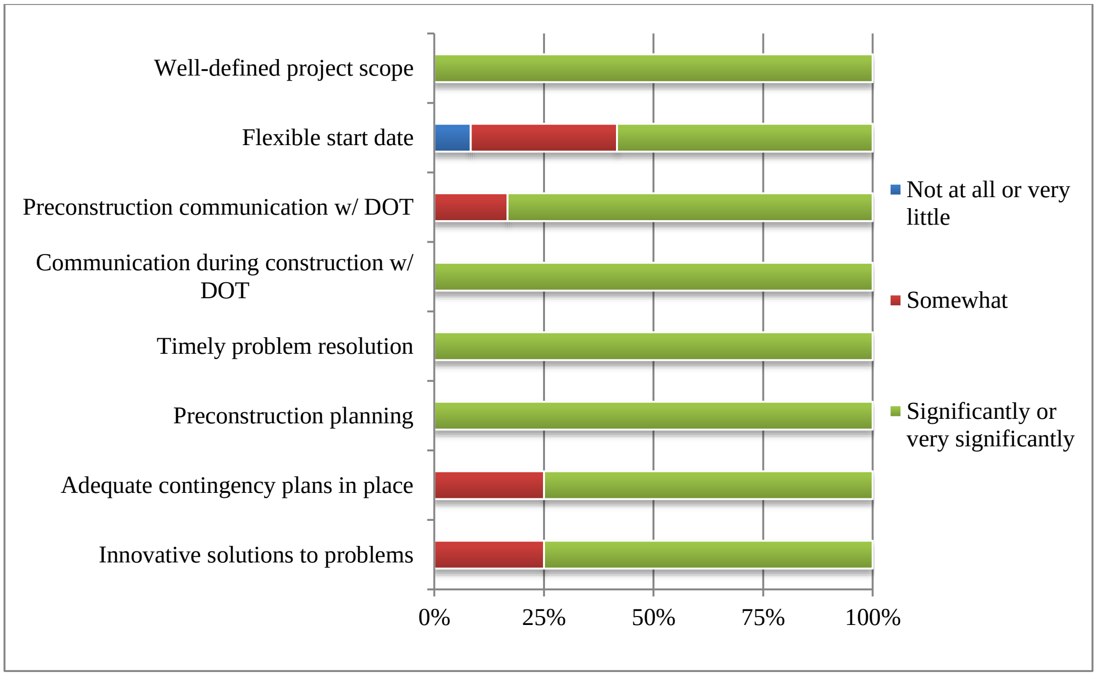

Figure 8-2 Contractor Responses to Acceleration Success Issues

DOT respondents were asked about what project characteristics most influence the decision to use I/D. The list of characteristics presented in the survey was taken from an FHWA contracting curriculum (FHWA, 2006) and observed characteristics of MoDOT's projects. Figure 8-3 shows that the two most influential characteristics are high traffic volumes facilities and major construction that will severely disrupt traffic. The second most influential are urban bridges and lengthy detours. The respondents were also asked if there were any specific project characteristic that had to exist before I/D was considered. 45.5% responded no, 23% responded that there needs to be major disruptions to the public, and the rest either just said yes without any specifics or brought up another characteristic such as project cost threshold.

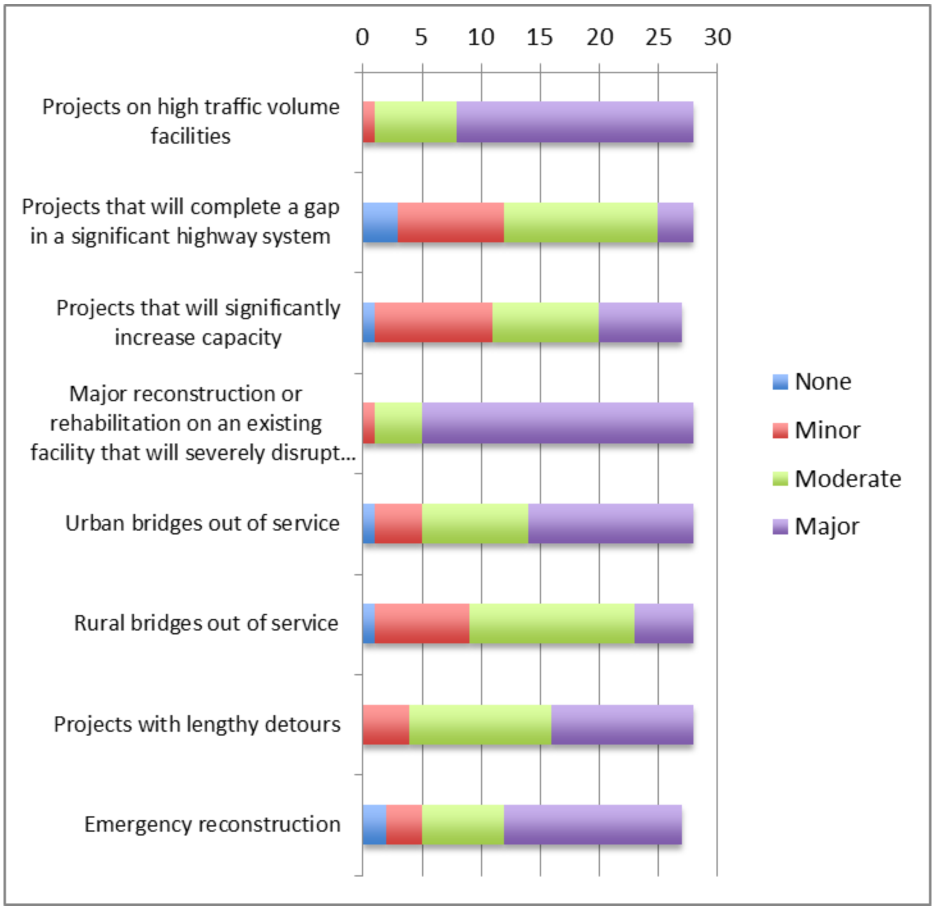

Figure 8-3 DOT Responses to Factors Affecting I/D Use

Respondents were asked how they set their I/D rates. The answers varied significantly among the sample. A third of the respondents used a numerical range between 10% and 100% of the RUC. 22% did not assign a quantitative percentage but said the amount was highly project dependent. Two respondents noted that the amount was set to achieve the intended goal, i.e. to induce acceleration. The related question of how contractors establish their construction acceleration costs were not asked of contractors. The question was not asked because such information is confidential as it affects a contractor's competiveness.

The challenges of I/D use were ranked by respondents on a scale from very significant to not at all. Figure 8-4 shows DOT responses. According to DOT, the most significant challenges were poorly defined project scope, plans and specifications errors and utility conflicts. The least significant were weather delays, difficulty in scheduling activities and worker morale. The corresponding contractor responses are shown in Figure 8-5. Contractors ranked almost all challenges as significant. They agreed with DOT that worker morale and difficulty in scheduling activities were not very significant. A major difference in the response between DOT and contractor was that the contractor thought weather delays were a more significant challenge

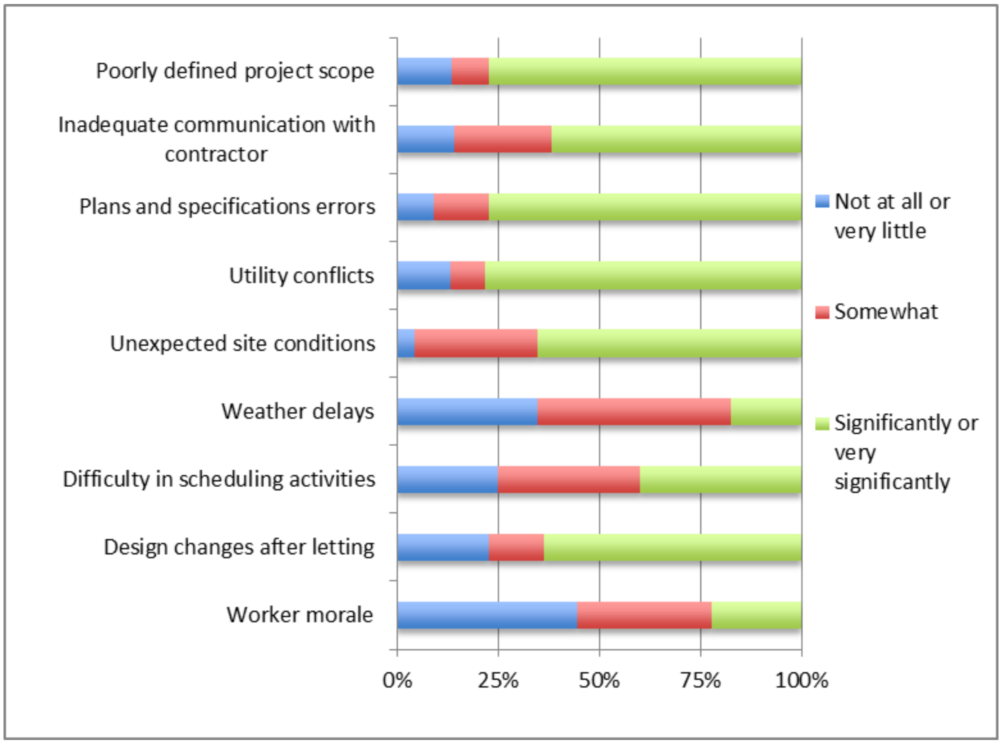

Figure 8-4 DOT Responses to Challenges to I/D Use

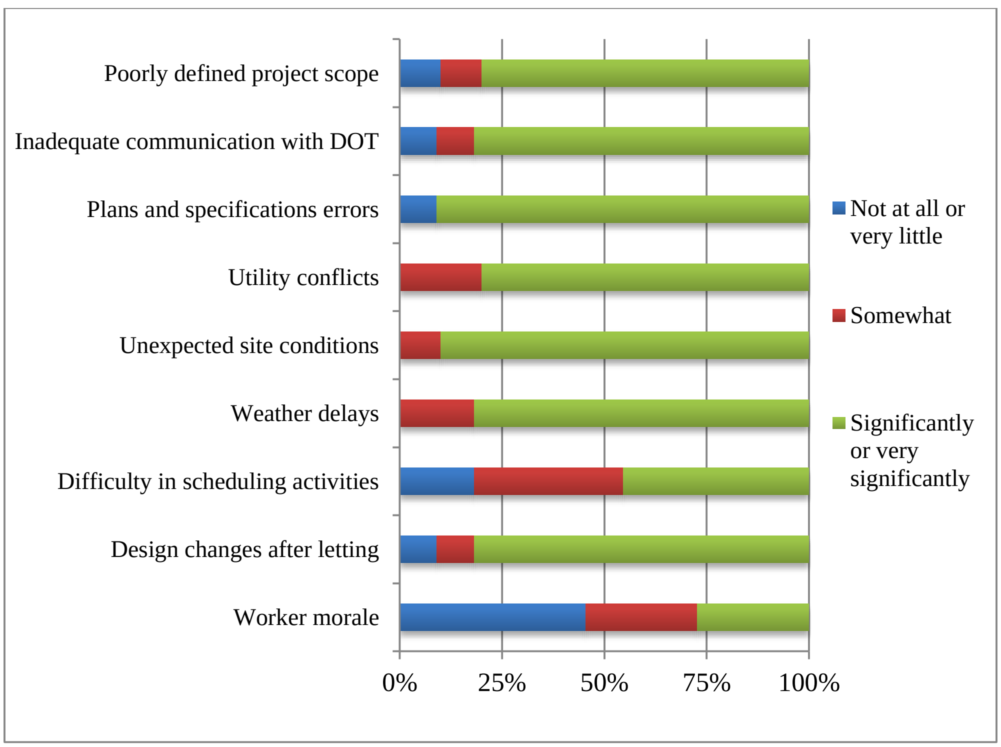

Figure 8-5 Contractor Responses to Challenges to I/D Use

One question asked directly about the impact of the I/D provision to motivate construction acceleration. A majority of DOT respondents (77.8%) answered that the impact was significant or very significant. The contractor responses were similar at 72.7%. A related question asked if projects could be further accelerated if the number of incentive days were increased. 18.5% of DOT respondents replied definitely or probably, but 45.5% of contractors replied definitely or probably. Perhaps this reflects a DOT misconception that contractors would not be further motivated to accelerate beyond a certain number of days. This result would suggest to DOT to try more incentive days if the budget allows on a particular project.

As previously discussed in the literature review, some suggest that some contractors might underbid on the contract amount with the hope of making up the profit with incentives. Even though a survey might not be the best instrument to explore this question, it could provide some insight into the validity of this suggestion. DOT and contractors were asked if I/D provisions typically have significant impact on bid amounts, and if I/D provisions result in higher or lower bids than normal. Table 8-1 shows survey the. Neutral responses were the majority for all three questions for both DOT respondents and contractors. For both parties, there were more responses that disagreed that I/D resulted in either higher or lower bids. It appears that the survey evidence does not support the notion that bid amounts are affected by I/D provisions.

Table 8-1 DOT and Contractor Responses to I/D Effect on Bid Amount

	DOT (%)			Contractor (%)		
I/D provisions typically:	Strongly Disagree or Disagree	Neutral	Strongly Agree or Agree	Strongly Disagree or Disagree	Neutral	Strongly Agree or Agree
Have significant impact on bid amounts than normal	7.41	44.44	18.52	0.00	36.36	27.27
result in higher bids for the job than normal	18.52	40.74	0.00	27.27	36.36	9.09
result in lower bids for the job than normal	14.81	44.44	7.41	18.18	45.45	9.09

9. Legal Analysis Of Incentive/Disincentive Contracts

Legal citation differs significantly from other forms of citation including what is common in transportation engineering. For example court cases and statutes require very precise descriptions and could differ among different states. In order to prevent confusion, a completely different citation system is employed in this chapter, and a separate reference list is included at the end of this chapter.

9.1. Introduction

The Code of Federal Regulations defines an incentive/disincentive (I/D) for early completion as "a contract provision which compensates the contractor a certain amount of money for each day identified critical work is completed ahead of schedule and assesses a deduction for each day the contractor overruns the incentive/disincentive time." (1) The law concerning I/D contracts and contract acceleration is very fluid, since such practices are relatively new and not well-litigated. For example, one well-known case in Tennessee that allowed the modification of an incentive clause, *Ray Bell I* (2), was overturned in *Ray Bell II* in 2011 (3). The purpose of this chapter is to alert agency attorneys and perhaps contract engineers of some of the issues that have surfaced in court cases concerning I/D contracts. The intent is to make this chapter accessible to non-attorneys, but important legal language and terms of art had to be used for conciseness.

The most important influence behind I/D contracts in transportation is arguably the Code of Federal Regulations and specifically § 635.127 in Title 23, which concerns provisions affecting contract time overruns (4). The contract procedures described in Title 23, Part 635, including § 635.127, is applicable to all Federal-aid highway projects. Thus these regulations influence significantly the contracting practices of the department of transportation (DOT) of various states.

The Federal Register (5) discusses the background and motivation behind the authorization of I/D clauses in 1987 in § 630.305 (6), re-designated as § 635.127 in 1997 (7). The regulations enacted in Subpart 635 were intended to improve the assessment of damages for contractor overruns in the following ways. First, the regulations discarded outdated damages rate tables from 1972 that were based on nationwide averages. Second, they instituted a requirement for states to maintain and update their own rate tables. Third, the regulations addressed the use of liquidated damages to include delay-related costs beyond the daily construction engineering (CE) costs. Fourth, they corrected a previous inequity in the computation of the federal pro rata share of liquidated damages. And last, I/D was defined and described. One motivation for authorizing I/D clauses is to facilitate the inclusion of road user costs (RUC) such as delays and safety impacts in critical projects. RUC are damages in addition to construction engineering (CE) costs.

Finch (8) describes the legal basis for disincentive clauses as the liquidated damage provision from typical construction contracts. The often cited *United States v. Bethlehem Steel Co.* (205 U.S. at 105) is a paradigm case for illustrating the enforceability of liquidated damages (9) (10). In terms of construction contracts, Harp (11) suggests that the vast majority of courts have followed the lead of the Supreme Court decision in *Robinson v. United States* which held that a liquidated damage clause is not contrary to public policy and is a suitable means of inducing performance, or of providing compensation in the case of failure to perform (12). If I/D is rooted in liquidated damages, then why stray from the foundation by introducing the concept of disincentives? The section entitled “Discussion of Legal Issues” will present some reasons for replacing disincentives with liquidated damages.

Although all fifty states and the federal government have enacted statutes with respect to liquidated damages (10), the three typical liquidate damages enforceability elements are: 1) damages are uncertain and difficult to prove, 2) parties must have intended for the liquidated damages in advance, and 3) the stated amount must be a reasonable estimate of the loss upon breach (13). The well-known contradiction between the first and third elements is the requirement for a reasonable estimate which also has to be uncertain (11). In the majority of jurisdictions, reasonable is interpreted as not being disproportionate to the probable loss at the time of the contract (14). However, minority jurisdictions require that there be a reasonable approximation between the liquidated amount and the **actual loss** and not just probable loss (11).

In general, construction damages resulting from a contractor’s failure to complete work within a specified time is the value of the use of the building for the period of delay (15). Harp (11) explains that this value includes engineering charges, losses in toll revenues, if applicable, and cost to the public. The last category includes value of time lost in delay, extra fuel expended, increases in accident frequency and severity, economic impact of surrounding areas, and inconvenience to adjacent property owners. The difficulty in establishing the cost to the public might be one motivation for introducing the concept of I/D.

Heckman suggests that a symmetric I/D structure has a higher likelihood of enforceability because an incentive is offered to offset the potential for disincentive damages (16). Traditionally, the most significant component of an owner’s delay is actual damages in the form of lost revenues. For a DOT, however, the impact of delays is not in lost revenues but in road user costs (RUCs) and other societal costs. Thus DOTs might face difficulties in proving consequential damages because of foreseeability and reasonable certainty requirements. These issues might be the reason why current I/D contracting practices incorporate separate liquidated damages and I/D clauses into the same contract. Most agencies attribute liquidated damages and disincentives to different types of damages that could result from a breach. According to NCHRP 652, liquidated damages are typically based solely on the recovery of an agency’s daily construction engineering costs while incentives and disincentives are based on road user costs (17). Another justification for the collection of RUC is based on the *parens patriae* doctrine which says the federal government and the states may vindicate the interest of their citizens under appropriate circumstances (18).

On the surface, there is symmetry in incentives and disincentives since they are both designed to accelerate contract performance (10). But the legal foundations for incentive and disincentive clauses are quite different. Thus the promotion of symmetry in I/D clauses could actually work against enforceability. The concern for incentive clauses is that such clauses might run afoul of state competitive bidding statutes (19). Such statutes are designed to prevent favoritism and fraud, and to ensure uniform and equal bidding. A potential problem in using incentives is the strategy of bidding low in anticipation of receiving bonus payments to make up for the initial bid price. Such problems are different from the ones encountered in disincentive clauses.

Incentive and disincentive clauses also differ in terms of practical consequences. It is unlikely that contractors, who are entitled to a bonus, would challenge its validity; thus potential litigants are reduced to competitors or taxpayers. Furthermore, incentives do not have to be paired with disincentives. Harp (11) argues that courts have not held that the lack of a bonus provision rendered a liquidated damage provision unenforceable.

9.2. CASE FACTS AND BACKGROUND

Since most court cases involve multiple issues, the facts from important modern I/D cases are first explained in this section. Then the various legal issues from these cases will be discussed issue by issue in the next section.

Milton Cases

Two companion cases are referred to as *Milton II* (20) and *I* (21). *Milton II* affirmed the rulings on road user costs and a disincentive provision from the *Milton I* case. Both cases involved a dispute over disincentive payments to the amount of $534,000 that was withheld from the contractor by the highway department. The contract involved the construction of two interstates: I-65 and I-59 in Jefferson County, Alabama. The total cost of the projects was around $7.7 million and $4.4 million respectively. The incentive/disincentive contract specified that the project must be completed and accepted within 330 calendar days for I-65 and 210 calendar days for I-59. For each day of overrun, the contractor was assessed a disincentive payment of $5000 per day for I-65 and $4000 per day for I-59, up to 60 calendar days. The disincentive amounts were in addition to liquidated damages which were $600 per day for I-65 and $450 per day for I-59. Milton exceeded the time for completion by 156 days for I-65 and by 72 days for I-59. This led to the imposition of $93,600 in liquidated damages and $300,000 in disincentives for I-65, and $32,400 in liquidated damages and $240,000 in disincentives for I-59.

One important issue to note is the standard of review that was applied in this decision. The lower court had granted summary judgment in favor of the highway department, meaning the court determined that there was no genuine issue of material fact that could be litigated. Therefore, in its review, the Alabama Supreme Court viewed all inferences in the light most favorable to the contractor, Milton. This case illustrates one end of the spectrum of decisions: decisions that invalidated incentive/disincentive contracts. Not only did the Alabama court overturn the summary judgment from the lower court, it considered the issue over the incentive/disincentive contract as a matter of law and decided it on the merits directly without remanding the case back to the lower court.

Ray Bell Cases

These companion cases involved a dispute over incentive payment for constructing the I-40/I-240 Midtown Interchange in Memphis, Tennessee (22) (23). The funding was split 90% from the FHWA and 10% from Tennessee Department of Transportation (TDOT). The funding structure was significant because of the FHWA policy to eliminate the use of the pro-rata method for calculating time extensions on quantity overruns. In accordance with this policy, TDOT included a "no excuse bonus" provision that specified that the completion date will not be adjusted for any reason except for catastrophic events. The contract specified that the project shall be completed in its entirety on or before December 15, 2006. The incentive payment of $10,000 per day was capped at a maximum of $2 million, and the disincentive payment, also at $10,000 per day, was uncapped. Ray Bell requested a 289-day extension for all dates but did not accept TDOT's offer of a 137-day extension of the completion and disincentive dates and no extension of the incentive date. After the completion of the contract, Ray Bell requested a 362-day extension that was again countered by the same 137-day extension offer from TDOT. TDOT determined that the project was substantially completed on December 17, 2006, thus no incentives were paid. Ray Bell claimed it was entitled to $2.5 million in incentives. The Tennessee Supreme Court applied a de novo standard of review meaning there was no presumption of correctness to the lower court's ruling in favor of Ray Bell.

James Case

This case involved a dispute over the disincentive amount that was withheld for the construction of the Louisiana Avenue Interchange on I-10 (24). The contract between James and the Department of Transportation and Development (DOTD) was for the amount of around $19 million and a completion date of June 22, 2003, or a 440 day duration. The disincentive amount was specified as a $10,000 daily road user cost. James was assessed $420,000 for completing the project on August 28, 2003. A de novo review standard was used.

River Road Case

Even though this case did not involve an incentive/disincentive contract or road construction, it is included because the holding cited and discussed *Milton II* (25). River Road was a dredging subcontractor to Radcliff for a liquid-bulk terminal project with the Alabama State Port Authority. River Road claims additional expenses of around $1.1 million for the unanticipated discovery of rock during dredging. The standard of review of the trial court's denial of the motion to dismiss was to view River Road's complaint in the most favorable light.

Bonacorso Case

The Department of Public Works (DPW) had contracted with Bonacorso Construction (BCC) to rebuild two bridges on I-93 in Reading, Massachusetts (26). The completion date was November 28, 1987, and a disincentive of $4000 per day was assessed for late completion. DPW and BCC had amended the contract with a new completion date of December 6, 1988, but work was not completed on that date. The contract incorporated DPW's standard specifications which provided that the contractor shall have no claim for damages of any kind on account of any delay.

Although the standard of review was not stated explicitly, the court appears to have made a de novo review.

Good Hope Case

This case will be referred by the contractor's name, Good Hope. Alabama Department of Transportation (ALDOT) had entered into three contracts with Good Hope to undertake various road projects (27). The contracts specified liquidated damages based on the number of days exceeding the limit, and ALDOT withheld around $600,000 in liquidated damages. Since the action was a writ of mandamus to compel a lower court to dismiss, the standard of review was whether Good Hope may possibly prevail while construing all doubts regarding the sufficiency of the complaint in favor of Good Hope.

Harbert Case

Harbert International (Harbert) was awarded two contracts by the Alabama Department of Transportation (ALDOT) to replace the Cochrane Bridge over the Mobile River (28). The liquidated damages amount for delayed completion was $4000 total per day for both contracts. The amount assessed was $534,000 for completion beyond the August, 1991, timeframe. Though the standard of review was not stated explicitly, the court appears to have made a de novo review.

Vrana Case

The Department of Roads in Nebraska (DOR) had contracted with Vrana & Son (Vrana) to reconstruct a road and two bridges (29). The contract specified a duration of 412 days, a liquidated damages amount of $875 per day and incentive/disincentive clauses. The incentive rate was $4700 per day to a maximum of $9400, and the disincentive rate was $4700 per day with no maximum. The scope of review was for the appellate court to reach a conclusion independent from the lower court. The appellate court found that it did not have jurisdiction to rule on the substance of the case since the lower court only granted a partial summary judgment and not an appealable final order.

Anjo Case

The Pennsylvania Department of Transportation (PennDOT) contracted with Anjo Construction (Anjo) to rehabilitate the Highland Park Bridge in Pittsburgh, Pennsylvania (30). This bridge was the second busiest bridge in Pittsburgh. For the floor beam replacements phase, there was an incentive of $43,000 per weekend up to a maximum of six. For bridge closures, there was an incentive of $14,350 per day up to 100 days. Due to omissions and errors by the outside engineering firm, the project was extended by 64 days on June 4, 1987. Thus the completion date was moved to March 18, 1988 but the incentive payment date for opening the bridge to traffic was kept at December 9, 1987. Anjo completed the project by December 9, 1987 and received the full incentive payment. But Anjo claimed it was entitled to more payments due to acceleration among other issues.

9.3. DISCUSSION OF LEGAL ISSUES

Enforceability

The first and perhaps the most important issue concerning I/D contracts is the enforceability of such contracts. The comments to the proposed rulemaking to § 630.305 in 1987 foreshadowed the enforceability issues that arose in later court cases. One commentator expressed concern over the separation of the CE and delay-related costs that might "jeopardize the enforceability of the liquidated damages provision." (5) Courts have recognized the right of freedom of contract and are adverse to holding contracts unenforceable unless they are illegal or they clearly violate the public policy of the state (31). One such violation of public policy occurs when a contract provision is construed as a penalty. There are several examples where contractors have sought to invalidate disincentive or liquidated damages clauses on such a theory. In *Good Hope* and in *Harbert*, the contractor sought to invalidate the liquidated damages provision as an unlawful penalty. In *Vrana* and in *Milton I*, the disincentive provisions were ruled to be penalties and unenforceable. Furthermore, the issue of enforceability is a matter of law that is decided by the judge. The *Vrana* court granted a partial summary judgment on this basis. The Alabama Supreme Court in *Milton I* invalidated the disincentive clause instead of remanding even though the appeal was of the lower court's granting of summary judgment in favor of ALDOT. Summary judgment means that there is no genuine issue of fact to be decided by a jury in jury cases.

As explained in *Williston*, the determination for when a clause is treated as a penalty is not a clear line (32). But courts do look at whether breach damages are reasonably susceptible to be measured by some adequate and approved legal standard. The *Milton I* (2010) court discussed the typical criteria for deciding if an amount should be characterized as a penalty. They are: 1) the breach injury must be difficult to accurately estimate ahead of time, 2) the parties must intend for the amount to be for damages and not penalties, and 3) the amount must be a reasonable estimate of damages. The language used in I/D or liquidated damages clauses is not dispositive in construing such clauses as non-penalty. Thus courts will disregard self-serving language and look beyond the label that was applied in the contract clauses to the actions of the parties (16).

Regarding the second criterion, the *Milton I* court held that ALDOT unilaterally decided to include a disincentive clause prior to any negotiations with Milton. This ruling appears to be problematic in light of typical agency contracting and bidding procedures through which contracts are awarded. Perhaps, this would suggest that the use of A+B bidding with I/D contracts might be considered less unilateral, since the bidder submits the cost and time for completion. On Criterion 3, the *Milton I* court stated that ALDOT conceded that it arbitrarily set the dollar amount of the per-day assessment and the maximum time limit for the assessment in the disincentive clause. It is therefore important for agencies to document their basis for disincentive and liquidated damages amounts and time limits. One commentator also recommends the documentation of negotiations with contractors as to the amount of liquidated damages (16), but such negotiations are not typical in public highway construction.

Taking a different approach than the use of I/D clauses, one possible suggestion from this chapter is to discard disincentives in favor of including all the categories of damages in the liquidated damages clause. Thus liquidated damages would include all potential types of damages including engineering costs, construction costs, administration costs, road user delays and safety impacts. One major reason for this suggestion is the danger of having performance acceleration construed as a penalty. The *Milton I* court cited Williston (32) to show that a provision included to stimulate performance was unenforceable. The court emphasized contract language that stated it was "in the public's interest to complete this project at the earliest possible date", thus the disincentive clause acted as a discouragement or penalty for late completion. The disincentive clause was construed as a security for contract performance via financial punishment and not as compensation for public delays. The *Milton I* court differentiated disincentives from liquidated damages by saying one was designed to punish a party who breaches while the other was an amount paid in lieu of performance. It is arguable whether project acceleration and damage compensation are that different from each other. In the field of transportation, there is significant research documenting the relationship between work zone duration and traffic impacts for both safety and mobility. From a practical standpoint, an additional day of construction necessarily means that more delay and safety damages result, though the magnitude of impacts varies from location to location. However, the *Milton I* court seems to say performance acceleration and damage minimization are categorically different. It appears that the court is treating the disincentive phase of a contract as performance and not breach.

Another reason for eliminating disincentives is the potential for liquidated damages and disincentives to overlap. As seem in *Milton I and II*, any double inclusion of damages in multiple contract clauses could render one clause as redundant and unenforceable. The *Milton II* court stated that since the liquidated damages clause accounted for delays, there could be no recovery for the road user costs in disincentives. The court described the double recovery as passing "the limit of reasonableness". The Code of Federal Regulations (CFR) § 635.127 (c) states, "The STD [state department of transportation] may, with FHWA concurrence, include additional amounts as liquidated damages in each contract to cover other anticipated costs of project related delays or inconveniences to the STD or the public … road user delay costs may be include." (7) The Federal Register explained that FHWA recognizes liquidated damages to include not only CE costs but other project delay-related costs (5). In § 635.102, the definition for I/D for early completion includes "estimates of such items as traffic safety, traffic maintenance, and road user delay costs." (1) Thus delay-related costs could be included in both liquidated damages and disincentives, and that double inclusion could make disincentives a subset of liquidated damages.

A third reason for discarding disincentives is that incentives and disincentives are not symmetric in terms of their legal underpinning. Unlike disincentives, incentives cannot be considered a penalty and be ruled unenforceable. But incentive clauses have their own issues in that they might be labeled as gifts or bonuses which might violate public contracting laws. It then appears that incentives and disincentives have different enforceability concerns. This theoretical asymmetry is also supported by empirical data. According to Gao (33) incentives are applied much more often than disincentives. For example for 32 Kentucky projects, $10,868,395 was paid in incentives while only $21,500 was paid in disincentives for a ratio of 506 to 1. Two possible explanations are contractors' desires to maximize earnings and DOTs setting overly conservative completion dates. Unfortunately it is difficult to know the exact reasons as actual acceleration costs and profits are not disclosed by contractors. Despite this fact, the empirical asymmetry supports the notion that the legal basis behind incentives and disincentives are quite different.

The proposed approach is the opposite of CFR's approach in promoting the use of I/D. CFR explains that I/D provisions are intended for use on those critical projects where traffic impacts should be minimized (4). By reserving I/D for higher traffic impact projects, there is an emphasis that these kinds of impacts might be unusual and merit closer scrutiny. In contrast, the proposed approach is to let the liquidated damages amount speak for itself. On the higher traffic impact projects, the RUC amounts will naturally be higher. And on projects where traffic demands are under the work-zone or detour route capacities, then the liquidated damages amount will be commensurate with zero RUC cost. This approach tries to justify all types of damages directly on the basis of liquidated damages. In contrast, the I/D approach could end up with two related legal hurdles instead of one: to prove that disincentives are liquidated damages and to establish that the liquidated damages are not penalties.

Other I/D Legal Issues

If a court determines that an agency ordered the acceleration of a contract beyond what was specified in the original contract, then the contractor may recover for costs incurred for accelerating project performance. The opposite could also occur, where an agency excuses the contractor for delays. The more unique situation is when an agency expressed no specific commands and yet is held to have constructively ordered the contractor to accelerate. The *Anjo* court states that such a case could exist when an agency asks a contractor to accelerate or merely expresses concern about the lagging process (30). In *Anjo*, the project was delayed because of design and other errors beyond the contractor's control. The performance date was extended but not the incentive payment date. But instead of treating the tardiness as an excusable delay, the court ruled that there was constructive acceleration so that the contractor should receive the maximum incentive payment. The court reasoned that the contractor accelerated the work to meet project deadlines and not to earn the incentive payment. The support for its decision was that the contractor's increase in labor costs was greater than the maximum incentive payment. It is surprising that the court made an economic argument based on the difference between the increased actual labor cost and the incentive payment during the time of performance. Despite the problematic economic justification, *Anjo* cautions against the owner treating the completion and incentive dates as different.

Constructive suspension is a delay order that is inferred from the actions of an agency that causes a delay. In *Bonacorso*, the contractor asked the court to adopt the principle of constructive suspension to recover damages such as idle equipment, labor rate escalations and home office overhead (26). The court ruled that the exchanges between the contractor and the agency were deficient as an order because it did not accurately describe the number of delay days ordered thus there was no reasonable basis for accurately estimating delay damages.

Though not unique to contract acceleration cases, the role of sovereign immunity has appeared in many I/D cases. Sovereign immunity means a state and its agencies have absolute immunity from suit in any court. Some exceptions to this doctrine include actions to compel a state official to perform his/her duties and declaratory judgments. A requirement in such actions is that the proper state official in his/her representative capacity must be included as a named defendant. For example in *Milton II*, the court affirmed the validity of suits that named the proper state office in his/her representative capacity (20). But in *Good Hope*, the case was thrown out because the agency, ALDOT, was named and not the director of the agency (27). In both *Milton* and *Harbert*, the courts held that the exception to compel a state official to perform his/her duties was met (20) (28). The courts explained that once the highway departments had legally contracted under state law for services and accepted the services, then the obligation to pay was not subject to sovereign immunity. In *Milton*, the court ruled that the disincentive clause was unenforceable as penalty. In *Harbert*, even though the court allowed the suit to go forward, the court ultimately ruled for the agency holding that the damages against the state are an unconstitutional divestment of state treasury funds. The contractor had sought un-liquidated damages for the agency's failure to consider another scheduling sequence and for extra work performed.

In *Good Hope*, the court considered the contractor's argument that ALDOT could be sued because of the declaratory judgment exception (27). The contractor asked the court to invalid the liquidated-damages clause as an unenforceable penalty. However, the court characterized the case as nothing more than action for damages. The court explained that the exception applied only when the action seeks no relief other than the construction of a statute and how it should be applied in a given situation. Likewise in *River Road*, the court distinguished the case from *Milton* and characterized the claim for unanticipated expenses as an action for damages and not a declaratory action (25).

In *Ray Bell*, the court considered the parol evidence rule which affected the admissibility of external evidence in interpreting the incentive/disincentive contract (23). Under this rule, an ambiguous contract could be interpreted using extrinsic evidence. The court held that the plain language of the contract, including the incentive/disincentive provisions, was unambiguous thus the contractor was not entitled to use extrinsic evidence to prove the incentive payment date was changed contrary to the contract language. *Ray Bell* also discussed the Critical Path Method (CPM) for construction scheduling and its importance in incentive/disincentive contracts. If a delay were to arise, then CPM will help to determine which tasks were critical and dependent upon previous tasks.

9.4. SUMMARY

In light of the legal issues that have surfaced in *Milton I and II* as well as in other I/D cases, the following agency best practices are suggested. The most significant recommendation is to discard disincentives in favor of including all damages as liquidated damages including road user costs (RUC). This approach would prevent disincentive clauses from being construed as mere performance acceleration thus unenforceable as a penalty. This will also avoid specifying overlapping RUC damages in both the liquidated damages and in the disincentive provisions. Furthermore, incentives and disincentives have different enforceability issues. The former could be construed as unenforceable penalties, while the latter as illegal gifts or bonuses. If indeed I/D is rooted in the foundation of liquidated damages, then a deviation in language could forfeit such a bedrock.

The authors are aware that DOTs need to carefully balance many issues beyond just legal issues. One issue that motivated the historical use of disincentives is the promotion of public understanding and acceptance of incentives. Those who advocate for the symmetry in incentive/disincentives contracts suggest that this symmetry helps to justify the use of incentives to the public. But could not incentives coupled with liquidated damages serve the same purpose as I/D?

It is important for agencies to document their basis for the disincentive and liquidated damages amounts and time limits. This documentation helps an agency to establish that damages are difficult to accurately estimate ahead of time and that the amount specified in liquidated damages is reasonable. The communication of the basis for liquidated damages to contractors could also help to establish that both parties intended for the amount to be damages and not penalties. But self-serving language in the contract might not be dispositive in the enforceability determination.

Agency staff should be careful in what they communicate to contractors concerning project acceleration or suspension even if the acceleration was not written in the original contract. Courts could apply the theory of constructive acceleration and hold that a contractor was entitled to incentive payments even if work was completed beyond the date specified. Thus a court could construe communications as actual orders that modify a contract. Similarly, a court could excuse a contractor from disincentive payments if they found that an agency constructively approved delays.

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10. Conclusions and Recommendations

Project acceleration has become a national focus. The newly enacted transportation bill, Moving Ahead for Progress in the 21st Century, emphasizes accelerated project delivery and innovation (FHWA 2012). Innovative contracting techniques such as incentive/disincentive contracting could be one tool for ensuring the timely delivery of transportation projects. One previously unanswered research question was whether work zone impacts are mitigated using I/D contracts. This study reports the results from an examination of completed I/D projects in Missouri from 2008 to 2011. Data shows that I/D projects reduced both mobility and safety road user costs. The average days saved was around 11 days and the average total RUC savings was over $444,000 per project. Contractors appeared to be aggressive in pursuing incentives and avoiding disincentives. No contractors were assessed disincentives while fourteen of the twenty contractors obtained the maximum incentive amount. In total, I/D projects saved around $8.9 million in road user costs while only paying a little less than $1.7 million in incentives. The savings corresponded to a reduction of 214 days in construction. The RUC savings and schedule reduction were achieved with an average I/D rate discounted to 16.7% of the daily RUC and a maximum incentive of 3.4% of the original contract amount.

The effectiveness of I/D for various project characteristics was analyzed. Urban projects, full-closure projects and emergency projects all seemed to be good candidates for I/D provisions. The net RUC savings was 80% for urban projects, 86% for full-closure projects, and 93% for emergency projects. Rural, non-emergency projects effectively saved RUC but not at the same level as other projects, only netting 33% of RUC savings.

A programmatic evaluation of all MoDOT projects showed that I/D projects deviated more than other projects from the programmed costs. However, such deviations (-11.82%) were not primarily produced by the I/D payouts since incentive payments only accounted for 2.32% of final contract costs. I/D projects were completed on time more often than other projects, which indicates that I/D contracts successfully reduce construction time. I/D projects also had a higher percentage change of award amounts to final amounts, but this change could be skewed by two projects. The concern that I/D contracts could reduce the number of qualified bidders due to different contractor's capabilities and the innovation required did not materialize. In fact, the average number of bids per call was higher for I/D than other projects. This is important for a competitive market, which could lead to lower award amounts for the DOT.

The survey of DOT and contractors shows that both are in agreement to the importance of various issues to the acceleration of construction. The success of an I/D contract depends on all parties understanding what is at stake and how to accomplish the specific goals at hand. These goals must be well defined early in process. Constant communication will insure all parties are on the same page and any problems will be resolved quickly.

The existing literature shows the sample size of evaluated I/D projects is limited. This study included a larger sample size of twenty I/D projects let by Missouri over a four-year span. The results show that I/D contracting is successful at mitigating work zone impacts. Further research could compare similar projects that do not include I/D provisions to those in this study. This could help resolve whether or not contractors actually use additional efforts to accelerate construction, which would justify using incentives. Comparing to non-I/D projects could also reveal how contractors are adjusting their bids in anticipation of incentives or to cover the increased risk.

The following is a list of recommendations based on the research results:

1) This report documents how I/D contracts are highly effective in mitigating work zone impacts such as traveler delays, wasted fuel and safety costs. For every dollar paid in incentives for I/D projects in Missouri, approximately 5.3 dollars of RUC costs were reduced. The programmatic analysis found that the number of contractor bids did not decrease for I/D projects, and contractor survey results showed that contractors were confident in their ability to accelerate projects. Thus this report recommends for DOTs to continue to explore the use of such contracts and perhaps to include the consideration of such contracts in their standard contracting process.

2) This report found that I/D contracts were highly effective for urban, full-closure and emergency projects, but were less effective for rural, non-emergency contracts. Therefore, this report recommends that DOTs consider the use of I/D contracts for urban, full-closure and emergency projects.

3) Based on the survey findings, this report recommends for DOTs to be mindful of three common challenges to I/D contract success: a well-defined project scope, timely problem resolution and good communications with contractors.

4) Based on the legal analysis, this report recommends that DOTs discard disincentives in favor of including all damages as liquidated damages including RUC. This approach would prevent disincentive clauses from being construed as mere performance acceleration thus unenforceable as a penalty. This will also avoid specifying overlapping RUC damages in both the liquidated damages and in the disincentive provisions. For an example of this approach, see the MoDOT liquidates savings/liquidated damages provision shown in Appendix B.

5) This report recommends that DOTs document their basis for disincentive and liquidated damages amounts and time limits. For example, this report used national manuals such as the Highway Capacity Manual and the Highway Safety Manual to compute traveler delays, fuel expended and safety crash costs. This documentation helps an agency to establish that damages are difficult to accurately estimate ahead of time and that the amount specified in liquidated damages is reasonable since it is based on real road user costs such as delays, fuel expended and safety costs.

6) DOT staff should be careful in what they communicate to contractors concerning project acceleration or suspension. Courts could construe communications as actual orders that modify a contract date or excuse a contractor from disincentives.

7) For future research, this report recommends that I/D contracts be compared against similar projects that do not include an I/D provision to determine whether contractors use additional effort to accelerate construction to justify incentives.

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APPENDIX A. I/D PROJECT DETAILS

Table A-1 I/D Contract Details

No.	Full closure?	Original Contract Amount	Final Contract Amount	Contract Time	Contract Time Adjusted
ID1	Yes	$588,464.00	$602,405.80	220	220
ID2	Yes	$3,492,032.80	$4,567,387.89	54	54
ID3	Yes	$2,633,985.63	$3,636,552.66	73	77
ID4	Yes	$3,293,570.90	$2,140,771.99	25	25
ID5	Yes	$1,290,131.07	$1,275,557.33	31	53
ID6	Yes	$2,129,437.87	$2,486,076.83	180	180
ID7	Yes	$2,097,000.00	$2,117,000.00	93	132
ID8	Yes	$483,025.24	$484,719.24	78	78
ID9	Intersection Access	$6,795,644.83	$7,193,598.94	260	260
ID10	Yes	$514,588.43	$509,306.58	297	297
ID11	Intersection Access	$13,705,018.30	$15,225,280.29	236	236
ID12	No	$2,881,819.99	$2,967,961.19	273	467
ID13	Yes	$574,492.26	$636,622.51	103	103
ID14	Yes	$2,650,395.06	$2,793,745.66	205	205
ID15	Yes	$14,838,238.82	$14,857,563.77	759	759
ID16	No	$559,158.73	$568,194.75	118	118
ID17	Yes	$331,913.90	$346,294.39	40	40
ID18	Intersection Access	$104,681.15	$100,621.65	46	46
ID19	Yes	$1,064,668.53	$1,169,251.10	135	135
ID20	Yes	$9,264,133.39	$10,360,309.87	234	834

Table A-2 I/D Project Location Details

No.	Route No	County	Location of Work	AADT	Functional Classification	Rural/Urban
ID1	169	Gentry	Island Creek, south of Stanberry	1,970	Minor arterial	Rural
ID2	136	Atchison	from Co. Rd. C Ave. to e/o Phelps City	1,858	Principal arterial	Rural
ID3	159	Holt	from west of Rt. 111 to east of Rt. P near Fortescue	1,008	Minor arterial	Rural
ID4	136	Atchison	from Rte D east to bridge east of Phelps City	1,858	Principal arterial	Rural
ID5	59	Buchanan	from the Missouri River bridge to Route 45 near Winthrop	9,520	Principal arterial	Rural
ID6	Delmar Blvd	St Louis	at I-170 interchange in University City	14,300	Principal urban arterial	Urban
ID7	24	Chariton	over Grand River west of Brunswick	1,975	Principal arterial	Rural
ID8	109	St. Louis	at the Woods Road intersection south of Route 100 in Wildwood	17,191	Urban major collector	Urban
ID9	179	Cole	Missouri Blvd & Route 179 intersection in Jefferson City	35,000	Principal urban arterial	Urban
ID10	B	Warren	I-70 interchange on southwest outer road & Route B	2,580	Minor arterial	Urban
ID11	I-55	Perry	in the northbound lanes from Route 61 to Route B near Fruitland	9,960	Interstate	Rural
ID12	9	Clay/ Jackson	from 10th Avenue to 3rd Street in Kansas City	30,000	Principal urban arterial	Urban
ID13	C	Franklin	south of City of New Haven at Bouef Creek	486	Major collector	Rural
ID14	136	Harrison	west of New Hampton to the route 69/13 intersection in Bethany	2,560	Principal arterial	Rural
ID15	41	Carroll/ Saline	over Missouri River in Miami	1,470	Minor arterial	Rural
ID16	I-70	Montgomery	east of route F near High Hill	16,760	Interstate	Urban
ID17	V	Jackson	from Little Blue Road to Murkins Road north aof Route 350 in Kansas City	10,692	Principal arterial	Urban
ID18	100	St. Louis	Rte. 270 & Marine Avenue and Rte. 100 & Holloway Road.	20,283	Major arterial	Urban
ID19	D	New Madrid	west of North Lilbourn between Route MM and Route E	1,600	Major collector	Rural
ID20	Noland Rd	Jackson	over I-70 in Independence	29,500	Principal urban arterial	Urban

Table A-3 I/D Provision Details

No.	I/D Goal	Calendar Days or Completion Date	ID Rate	Max Incentive	Max Incentive Days	Incentive Period	Days Actually Used	Days Actually Saved	Incentive Earned
ID1	Milestone	Calendar days	$2,000	$10,000	5	14	9	5	$10,000
ID2	Open to traffic	Completion date	$8,000	$80,000	10	34	19	15	$80,000
ID3	Project completion	Completion date	$3,000	$15,000	5	60	60	0	$0
ID4	Project completion	Completion date	$10,000	$100,000	10	25	15	10	$100,000
ID5	Milestone	Completion date	$12,000	$36,000	3	7	3	4	$36,000
ID6	Open to traffic	Completion date	$15,000	$225,000	15	127	112	15	$225,000
ID7	Milestone	Completion date	$10,000	$100,000	10	46	44	2	$20,000
ID8	Milestone	Calendar days	$5,000	$70,000	14	42	39	3	$15,000
ID9	Open to traffic	Completion date	$10,000	$70,000	7	242	222	20	$70,000
ID10	Milestone	Calendar days	$3,840	$7,680	2	4	4	0	$0
ID11	Milestone	Calendar days	$15,000	$300,000	20	175	155	20	$300,000
ID12	Open to traffic	Calendar days	$9,000	$156,000	18	135	114	21	$156,000
ID13	Open to traffic	Calendar days	$2,000	$60,000	30	85	53	32	$60,000
ID14	Milestone	Calendar days	$2,000	$10,000	5	12	10	2	$4,000
ID15	Open to traffic	Calendar days	$7,000	$504,000	72	365	365	0	$0
ID16	Open to traffic	Calendar days	$15,000	$25,000	1.67	17	11.4	5.6	$25,000
ID17	Project completion	Completion date	$5,000	$25,000	5	23	9	14	$25,000
ID18	Milestone	Calendar days	$2,000	$10,000	5	14	9	5	$10,000
ID19	Open to traffic	Completion date	$13,000	$100,000	8	117	109	8	$100,000
ID20	Milestone	Calendar days	$14,000	$448,000	32	90	58	32	$448,000

APPENDIX B. MODOT I/D JOB SPECIAL PROVISION (JSP)

LIQUIDATED DAMAGES / LIQUIDATED SAVINGS SPECIFIED JSP-03-05

1.0 Description. If construction of (*description of the work*), is not completed by (*unit of time, hours, calendar days, completion date*), the Commission, the traveling public, and state and local police and governmental authorities will be damaged in various ways, including but not limited to potential liability, traffic and traffic flow regulation cost, traffic congestion and motorist delay, with its resulting cost to the traveling public.

2.0 Liquidated Damages Specified for Failure To Complete Work on Time. These costs are not reasonably capable of being computed or quantified. Therefore, the contractor will be charged with liquidated damages specified in the amount of (R*oad User Cost or other justifiable amount*) per (*time frame in appropriate units*) for each full (*unit of time, hours, days)* that all (*description of the work, ex. All contract work shall be completed as directed in the contract and on the plans including guardrail and open to traffic*.)*)*, in excess of the limitation as specified elsewhere in the special provision. It will be the responsibility of the engineer to determine the quantity of excess closure time.

2.1 The said liquidated damages specified will be assessed in addition to any other liquidated damages charged under the Missouri Standard Specifications for Highway Construction, as indicated elsewhere in this contract.

2.2 This deduction will continue until such time as the necessary work is completed and traffic is restored.

3.0 Liquidated Savings Specified for Early Completion. The contractor may receive an incentive payment from the Commission, in addition to all other sums earned under the contract, if the contractor completes (*description of the work)*. To qualify for this incentive payment, (*description of the work)* must be completed. (*ex. All contract work shall be completed as directed in the contract and on the plans including guardrail and open to traffic*.) An incentive payment of (*RUC or other justifiable amount)* will be paid per (*unit of time, hours, days)* for each full (*unit of time, hours, days)* that the work described above is completed prior to (*time frame in appropriate units*). The maximum amount paid as liquidated savings will not exceed (*XX% or $XXX,XXX to be determined on a project by project basis, does not usually exceed 10%)* of the total bid for Job No. Jxxxxxxx.

3.1 In the event of an excusable delay, an extension of the contract completion time will not extend the date specified for determining any liquidated savings or incentive. Further, in the event of an excusable delay, if the contractor completes the work providing for liquidated savings or incentive on or before the milestone or other date, that shall not constitute a basis to claim acceleration costs in addition to the liquidated savings or incentive that may be earned.

3.2 The incentive payment described above is made, not as a bonus or gift, but as stipulated compensation in full for reduced risks, delay and inconvenience experienced by the traveling public, and for other reduced costs to the Commission and public resulting from early completion.

Appendix C. Select Survey Questions

The DOT and contractor surveys were designed and implemented using the web-based Survey Monkey tool. Skip logic was implemented meaning subsequent questions could be skipped depending on the preceding responses. Some of the following questions did not apply to contractors.

Has your agency used I/D contract provisions to accelerate construction?

◯ Yes

◯ No

Comments

How much consideration to use I/D do the following project characteristics receive?

	None	Minor	Moderate	Major
Projects on high traffic volume facilities	◯	◯	◯	◯
Projects that will complete a gap in a significant highway system	◯	◯	◯	◯
Projects that will significantly increase capacity	◯	◯	◯	◯
Major reconstruction or rehabilitation on an existing facility that will severely disrupt traffic	◯	◯	◯	◯
Urban bridges out of service	◯	◯	◯	◯
Rural bridges out of service	◯	◯	◯	◯
Projects with lengthy detours	◯	◯	◯	◯
Emergency reconstruction	◯	◯	◯	◯

Comments

Does your agency have specific characteristics a project must have to consider using I/D?

How is the daily (or hourly) I/D rate determined once road user costs are calculated? (i.e. Is it a set proportion of the road user cost or always 100%? Does it depend on project size and scope, pressure from the public, or importance of completion?)

How much did the following contribute particularly to the success of accelerating construction for I/D projects?

	Not at all	Very little	Somewhat	Significantly	Very significantly	Don't know	N/A
Well-defined project scope	◯	◯	◯	◯	◯	◯	◯
Flexible start date	◯	◯	◯	◯	◯	◯	◯
Preconstruction communication w/ contractor	◯	◯	◯	◯	◯	◯	◯
Communication during construction w/ contractor	◯	◯	◯	◯	◯	◯	◯
Timely problem resolution	◯	◯	◯	◯	◯	◯	◯
Preconstruction planning	◯	◯	◯	◯	◯	◯	◯
Adequate contingency plans in place	◯	◯	◯	◯	◯	◯	◯
Innovative solutions to problems	◯	◯	◯	◯	◯	◯	◯

Please list any other successes you feel were significant:

How much did the following create a challenge particularly to accelerating construction for I/D projects?

	Not at all	Very little	somewhat	Significantly	Very significantly	Don't know	N/A
Poorly defined project scope	○	○	○	○	○	○	○
Inadequate communication with contractor	○	○	○	○	○	○	○
Plans and specifications errors	○	○	○	○	○	○	○
Utility conflicts	○	○	○	○	○	○	○
Unexpected site conditions	○	○	○	○	○	○	○
Weather delays	○	○	○	○	○	○	○
Difficulty in scheduling activities	○	○	○	○	○	○	○
Design changes after letting	○	○	○	○	○	○	○
Worker morale	○	○	○	○	○	○	○

Please list any other challenges you feel were significant

How much did the presence of the I/D provision provide motivation to accelerate construction beyond normal circumstances?

○ Not at all

○ Very little

○ Somewhat

○ Significantly

○ Very significantly

○ Don't know

Comments

Could the project have been further accelerated if the maximum incentive and/or number of days available to earn an incentive were increased?

- Not at all
- Possibly
- Probably
- Definitely
- Don't know

Comments

Indicate your level of agreement for the following statements:

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I/D provisions typically have a significant impact on bid amounts than normal.	◯	◯	◯	◯	◯	◯	◯
I/D provisions typically result in higher bids for the job than normal.	◯	◯	◯	◯	◯	◯	◯
I/D provisions typically result in lower bids for the job than normal.	◯	◯	◯	◯	◯	◯	◯
I/D provisions could result in higher, lower, or similar bids depending on contract details.	◯	◯	◯	◯	◯	◯	◯

Comments