PERFORMANCE OF DEPRESSED MEDIANS ON DIVIDED HIGHWAYS IN ALASKA

PRELIMINARY PROJECT REPORT

Prepared by:

Ghulam H. Bham, Ph.D.

Jacob Minturn

Brendan Hafele

Osama Abaza, Ph.D.

Civil Engineering Department

University of Alaska Anchorage

Anchorage, AK 99508

for
Pacific Northwest Transportation Consortium (PacTrans)
USDOT University Transportation Center for Federal Region 10
University of Washington
More Hall 112, Box 352700
Seattle, WA 98195-2700

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PacTrans
Pacific Northwest Transportation Consortium University Transportation Center for Region 10
University of Washington More Hall 112
Seattle, WA 98195-2700

University of Alaska, Fairbanks
Department of Civil and Environmental Engeering
P.O. Box 755900
Fairbanks, AK 99775-5900 USA

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16. Abstract

The population of Alaska especially the city of Anchorage is steadily increasing. As a result, traffic volumes are higher and demands to add lanes to existing highways is increasing in order to relieve congestion. In Alaska, an expressway or freeway is a high-speed (≥ 50 mph), multilane, divided highway with partial access control. These divided highways typically utilize wide medians. These medians are considered an option to be replace with narrow medians in order to provide additional through lanes to cater to the needs of higher traffic volume and keep traffic congestion to a minimum. During the Alaska winter where snow accumulates in medians from October to April, drivers can lose control of their vehicles in slippery road conditions; however, these wide medians with heavy snow serve as a refuge to absorb the impact of a crash. The damage to a vehicle and its occupants can be minimal as a result. If the existing wide medians are used to construct additional lanes, these wide medians will no longer be available to act as safety cushions. On the contrary, a narrow median will mainly act as a barrier to separate vehicles traveling in the opposite direction. Without a depressed median (a vee ditch), single vehicle run-off-road crashes could evolve into multi-vehicle crashes among vehicles traveling in the same direction. These depressed wide medians also act as snow storage areas, allowing snow to be plowed on both sides of the road. Eliminating these medians will reduce the available snow storage space and require plowing all of the snow to the right and increase the snow load to one side of the road. A study is proposed that will examine the operational and safety benefits of 1) keep existing wide medians, and 2) replace existing medians with a) concrete barriers, b) high tensioned cable barriers, and c) another feasible alternative. Modern protective devices, such as cable barriers, offer protection with a lower risk of vehicle damage and personal injury than do traditional concrete barriers and guardrails. The study will evaluate the benefits of travel way that is safer to use. Further, the study will examine the benefits of higher traffic volume with minimal congestion to the cost of construction of additional lanes and property damage to vehicles as a result of collision with different types of barriers.

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DISCLAIMER

This report reflects the views of the authors and may/may not reflect the views of the AKDOT&PF.

EXECUTIVE SUMMARY

This report presents preliminary findings of a crash causality study on four divided highways with depressed medians in Alaska. The four highways this study examined are: the Glenn Highway, Minnesota Drive, the Seward Highway, and the Parks Highway. On these highways, during the winter months many drivers lose control of their vehicles. As a result, vehicles hit the snow accumulated in the depressed medians. In the summer, with no snow to cushion the crash, some vehicles who enter the median tend to continue through the median onto oncoming traffic from the opposite direction. One of the findings of this study is the high percentage of rollover crashes (73%) on these highways. This study also examined the police crash reports to identify the possible contributing factors behind the crashes and evaluate the performance of the median in the crash outcome. The questions to be answered are the effects of snow plowing operation, speed of vehicles, driver behavior, effect of snow berms, hydroplaning, etc. and their effects on the collision types and their frequency and levels of crash injury severity. The analysis also examined how effective the medians are at reducing rollovers and vehicles from crossing the median. Preliminary findings indicate that the majority of crashes (67%) are minor injury or property damage only rollover crashes. Most crashes occur in daylight on icy roads during the months of September through February. Driving at unsafe speeds, and loss of control are main factors in the majority of crashes.

Keywords: Rollover crashes, Cross Median crashes, Depressed Medians, Alaska

INTRODUCTION

The population of Alaska is steadily increasing, especially in the city of Anchorage. As a result, traffic volumes are higher, and the demand to add lanes to existing highways in order to relieve congestion is increasing. In Alaska, an expressway or freeway is a high-speed (≥ 50 mph), multilane, divided highway with partial access control. These divided highways typically utilize wide medians. During the Alaskan winter, where snow accumulates in medians from October to April, drivers can lose control of their vehicles in slippery road conditions especially after a snowfall and end up in these medians. Wide medians with heavy snow serve as a refuge to absorb the impact of a crash. As a result, the damage to the vehicles and its occupants can be minimal. However, in order to provide additional through lanes, to cater to the needs of increasing traffic demand, and keep traffic congestion to a minimum, these wide medians could be replaced with narrow ones. If the existing wide medians are used to construct additional lanes, these wide medians will no longer be available to act as safety cushions during a crash. On the contrary, a narrow median will primarily act as a barrier to separate vehicles traveling in the opposite directions. Without a depressed median, single vehicle run-off road crashes could evolve into multi-vehicle crashes among vehicles traveling in the same direction. These depressed wide medians also act as snow storage areas, allowing snow to be plowed on both sides of the road. Thus eliminating these medians will reduce the available snow storage space and require plowing all of the snow to the right, increasing the snow load to one side of the road.

Medians along Alaskan divided multilane highways are primarily depressed. Typical foreslopes for the medians in Anchorage range from 1V:4H to 1V:6H with widths varying from 26-52 ft. These medians also vary by the type of median, either flat-bottom ditch or v-shaped ditch. According to NCHRP 794 (*2014*), many of these slopes fall within the range, 1V:4H to 1V:7H, in which both rollovers and cross median crashes (CMC) are most prevalent. Alaska's medians are unique in the aspect that they can be used to store snow during the winter months. The stored snow acts as a crash cushion and helps mitigate CMC. However, the plowing of the highways leaves a snow berm, which may contribute to a higher rollover frequency. Thus, it is important to study the role that both the snow and the median play in crashes.

Crash data for the Glenn Highway, Minnesota Drive, the Seward Highway, and the Parks Highway shown in Figure 1 were examined, all divided highways with depressed medians mainly used by commuters. The Glenn Highway and the Parks Highway connect Anchorage with the Matsu Valley comprising mainly the cities of Wasilla, Palmer and Big Lake. The residents of Anchorage heavily use Minnesota Drive and the Seward Highway. The speed limit on these highways ranges from 60 – 70 mph. All of these highways suffer from rutting in the pavement. The Alaska Department of Transportation and Physical Facilities (AKDOT) has reported many crashes along each of these highway medians and are interested in countermeasures to mitigate crash severity and frequency. Two of the major concerns with the current medians are the number of vehicles that traverse through the medians and enter on-coming traffic, and the high number of rollover crashes that occur due to compacted snow within the median. High number of median crashes are also reported to occur mainly after a snowfall.

This preliminary study analyzes the factors that contribute to these crashes in order to examine how the medians performed and suggest possible countermeasures to rectify the problems.

LITERATURE REVIEW

Several studies have been conducted on median crash frequency and severity (such as Lane et al. 1995; Shankar et al. 1998; Donnell et al. 2006; Hu et al. 2010; Lu et al. 2010; Hu et al. 2011; Graham et al. 2014; Harwood et al. 2014). From these studies, it is clear that cross median or crossover crashes (CMC) often end in a fatal or severe injury. One of the ways to prevent CMC is to prevent vehicles from entering the median by optimizing roadway geometry. However, whether it is the presence of drugs/alcohol, drowsiness, or some other form of inattentiveness, the human factors are exclusively the cause in 57% of crashes and play a role in 93% of all crashes (HSM 2010). Roadway design factors contribute to 34% of all crashes (HSM 2010). By improving roadway design, the number of crashes can be reduced. However, there is design challenges, building a median to prevent CMC may contribute to other crash types such a rollovers. Roadway conditions and weather also affect median crash frequencies especially in winter climates where snow and ice can accumulate creating more dangerous driving conditions.

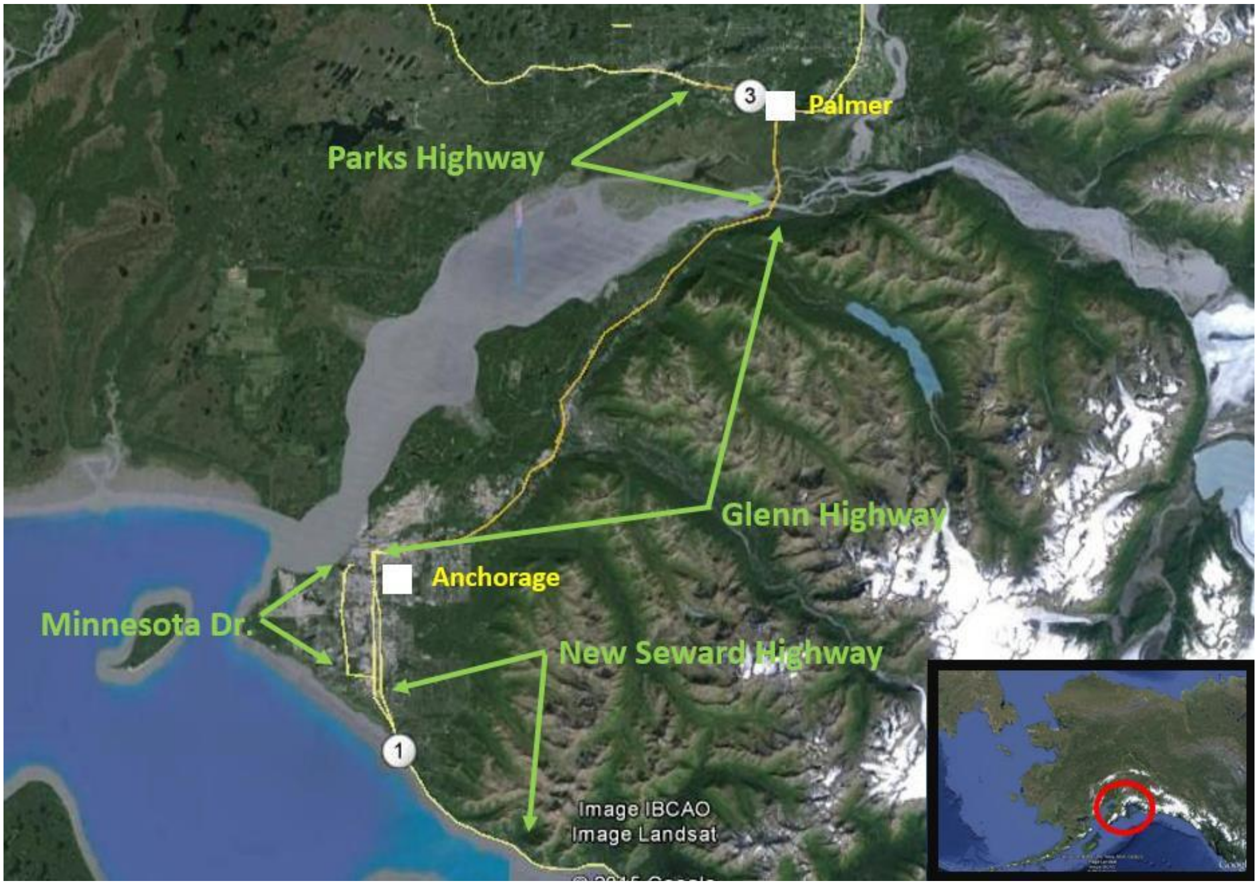

Figure 1. Location of the Four Highways near Anchorage, Alaska

NCHRP 790 (2014) examined factors leading to median crashes. Drivers losing control of their vehicle was a factor in 73% of median crashes. Contributing geometric factors explored were horizontal curvature and grade. Data was divided into categories and it was found that as the radii of horizontal curves decreases and as grade increases median crash frequency increased. The presence of on- and off-ramps also increased median crash frequency. Wet or snowy roads compounded with other factors to further increase median crash frequency.

It would be intuitive that crash frequency increases during winter months. However, this does not seem to be the case. Brorsson et al. (*1988*) found that in Sweden, when accumulated snow was 40 centimeters or less, for every centimeter of snow, minor injury, and severe injury/fatal crash frequency decreased 3.0 and 3.5 percent, respectively. This occurs despite an increase in property damage only crashes. Overall, in the presence of precipitation, crash frequency decreased. Hu and Donnell (*2011*) found similar results attributing reduction in frequency of severe crashes to safer driving.

The design of the median and how an errant vehicle interacts with its features is of appreciable concern. CMC are more likely to happen on traversable medians, medians without barrier or objects within them. Along with CMC the likelihood and contributing factors of rollover crashes are of interest.

Median width plays a crucial role in the prevention of CMC. The general thought is that as median width increases, a driver’s recovery time and space also increases. Hu and Donnell (2011) concluded that when a median is 70 ft. or less in width, then the probability of a fatal crossover crash is 5.05 times more likely to occur than when compared to wider medians. However, a fatal rollover crash is 3.25 times more likely to occur on a median 70-100 ft. wide. Shankar et al. (1998) are somewhat in agreement and concluded that medians 18.29 meters (60 ft.) and greater in width decrease crash frequency. Medians with two curves and widths between 9.14 and 12.19 meters (30 and 40 feet) are the type of medians where most cross median crashes occur.

According to Gattis et al. (*2005*), highways with depressed medians have the highest proportion of minor injury crashes. Despite this finding, Lane et al. (*1995*) found that fatal CMC and rollover crashes were 20% and 25%, respectively of all fatal crashes on median divided highways in Canada. In Pennsylvania, Hu and Donnell (2011) found that decreased median width and slopes flatter than 10H:1V or steeper than 7H:1V increased frequencies of fatal and severe crashes. Intuitively, the steeper the slopes of the median the harder it is for a vehicle to traverse the median. This is beneficial for preventing CMCs. However, it contributes to rollover crashes. For every unit increase in slope, there is a 5.8% increases in median rollover crashes (*NCHRP 794*).

Shoulders add additional recovery room for drivers in the case of run off-the-road crashes. However, shoulders that are too wide may cause a greater level of comfort and higher driving speeds and that could result in more sever crashes (*Hosseinpour et al. 2013*).

Both roadway and median design, and barriers can play an important role in preventing crashes and reducing the severity of crashes. However, the design is a balancing act. The challenge of designing an effective median is further compounded by both human and environmental factors.

DESCRIPTION OF DATA

This study analyzed crash data from 2007 - 2011 for the following divided highways: Glenn Highway, Minnesota Drive, Seward Highway, and Parks Highway. Two types of crash data were made available by the AKDOT: i) crash reports, and ii) archived crash data. The Anchorage Police Department and the Alaska State Troopers provided the crash reports to the AKDOT. Further information on crashes was obtained from interviewing the Anchorage Police Department as well as video recording the highways by driving regularly and after a snowfall event.

The police reports had information specific about crashes. Each report had various fields that the officers filled, such as the time and date of the crash, how many occupants, etc. Among these fields, the most important were selections such as the first sequence of events of the crash, human characteristics that accounted for the crash, the action the vehicle was performing, etc. All of the fields with short answers or fill in the bubble type questions were included in the archived data file. Moreover, the reports also had a section on the officer’s narrative of the crash, and a diagram to determine whether or not the crash ended up in the median, went through the median, and if the outcome of the crash was a rollover or not. All crash reports provided by AKDOT were redacted of driver’s personal information.

The police reports were used to determine whether the final outcome of the crash was a rollover or not and the location of the crash in relation to the median. Since the archived data file only showed the first and second sequence of events, the final outcome of the crash had to be determined by the police narratives and the crash diagrams. This information was added to the archived data to allow for easier data analyzing and to assist with future project research.

The AKDOT provided 1153 crash reports, however, 354 crashes were found to associate the median with the crash outcome. Table 1 presents the breakdown of where the 354 crashes occurred. The crashes were divided up first by rollovers and non-rollovers, then by crash location. This was carried out to determine if crash severity was dependent on the crash type. The assumption was that CMC (crossover crashes) typically result in fatalities or incapacitating injuries. Rollover crashes were also anticipated to result in significant vehicle damage and personal injury crashes. By determining the types of crashes that produce harmful/fatal crashes, AKDOT can modify the design of the medians to mitigate these crashes.

Table 1: Median Crash Types

Highways	Crashes Types	Rollover		Non-Rollover		Total Crashes
		Median	Crossover	Median	Crossover	
Glenn Hwy	Single Vehicle	143	19	40	13	215
	Multiple Vehicles	9	4	7	16	36
Minnesota Dr.	Single Vehicle	23	3	3	0	29
Seward Hwy	Single Vehicle	34	10	9	1	54
	Multiple Vehicles	3	1	0	2	6
Parks Hwy	Single Vehicle	7	2	4	1	14
Total Crashes By Type						
Single Vehicle		207	34	56	15	312
Multiple Vehicles		12	5	7	18	42
Total		219	39	63	33	354
Percent		61.86%	11.02%	17.80%	9.32%	-

From Table 1, it can be observed that Glenn Highway had the highest frequency of crashes with 251 crashes (71%) followed by Seward Highway with 60 (17%) crashes, Minnesota Drive with 29 crashes (8%) and Parks Highway with 14 crashes (4%) over a period of 5 years. Two hundred and eighty two (282) crashes (80%) occurred in the median and 72 (20%) crashes were crossover. There were 258 (73%) rollover and 96 (27%) non-rollover crashes. Single-vehicle crashes were 312 (88%) and multiple vehicle crashes (involving two or more vehicles) were 42 (12%) crashes.

Table 2 presents the frequency of crashes for the four highways separated by the four levels of crash severity. The crash severity is based on the KABCO scale as implemented by the AKDOT. Fatal crashes are the lowest, less than 2% of total crashes and incapacitating Injury (A). Total crossover crashes were found to be lower in crash frequency but higher in crash injury severity compared to total frequency of crashes in the median. The total number of rollover crashes is higher in frequency for all levels of crash injury severity when compared with non-rollover crashes.

Table 2: Levels of Crash Severity

Crash Severity	Rollover		Non-Rollover		Total	Percent
	Median	Crossover	Median	Crossover		
Fatality (K)	4	2	0	1	7	1.98%
Incapacitating Injury (A)	13	3	2	5	23	6.50%
Non-Incapacitating/Possible Injury (C)	85	20	14	13	132	37.29%
Property Damage Only (O)	117	14	47	14	192	54.24%
Total	219	39	63	33	354	-

A team of UAA researchers interviewed Sergeant Roy LeBlanc, the Traffic Unit Supervisor for Anchorage Police Department (APD). AKDOT arranged two meetings, one in October 2014 and another in March 2015. Sergeant Roy discussed APD's jurisdiction as well as when officers complete a police report on a crash. Police reports are generally only written if the car is part of a crime, or if there was enough damage to render the car disabled. Non-disabling crashes and property damage only crashes, although do not require a police report, are supposed to be called in by the driver of the vehicle or reported by others. This call gets recorded into APD's Computer-Aided Dispatch (CAD) system. Information such as the driver's name (if available), date, time, and location of the crash are recorded by the CAD system. Sergeant Roy reported seasonal variables and the snow berm as a factor in median crashes. He indicated that soft snow in the winter helps cushion the vehicles when they enter the median. However, as the spring's freeze/thaw cycle begins, the snow freezes into a hard structure. When a driver loses control during slippery conditions, vehicles hit the snow berm and rollover. He also said that in the summer, due to the lack of snow, cars have a tendency to traverse through the median and hit on-coming traffic.

The drive through video recordings were made during the winters of 2013-14 through 2014-15, thus they were not the same data set as the crash reports and archived data. The purpose of the recordings was to assess the contributing factors of the crash as well as help determine the number of occurrence of median encroachments. The video data was collected using two Garmin VIRB Elite cameras, which can record in 1080p and are equipped with a GPS. Videos were taken after snow events while the tracks were still fresh to capture the trajectory of the vehicle and to get its position in the median ditch. The purpose of the videos was to accumulate data that may not be reported at all, and to possibly use them in conjunction with the police reports in the future to supplement the reports.

The video data enabled the researchers to collect information not available through official reports. In Alaska, officials do not need to be contacted in the case of a property-damage only crash. Therefore, taking data from video leads to more accurate accounting of minor crashes. Crash median events do not always result in a collision, as such the video showed evidence of where vehicles cross the median. Using the video data may help find if crossing the median is a problem on Alaskan Highways and may help identify potential hotspots.

Table 3: Vehicle, Driver and Environmental Variables that Attributed to Crash

Variables/Categories	Rollover		Non-Rollover		Total
	Median	Crossover	Median	Crossover	
Vehicle Actions					
Avoiding Objects in Road	8	0	2	0	10
Changing Lanes/ Merging/Passing	25	2	5	2	34
Entering/Exiting Traffic Lane	7	3	0	1	11
Out of Control	66	14	16	21	117
Skidding	30	2	7	4	43
Slowing	3	0	1	0	4
Straight Ahead	68	15	26	5	114
Other/Unknown	11	2	5	0	18
Turning Left	0	1	0	0	1
Drugs/Alcohol					
Yes	20	7	6	6	39
No	199	32	57	27	315
Light Conditions					
Dark - Lighted Roadway	65	11	20	14	110
Dark - Roadway Not Lighted	26	5	10	1	42
Daylight	117	18	31	15	181
Twilight	10	4	2	2	18
Not Rep./Unknown Lighting	1	1	0	1	3
Surface Conditions					
Dry	49	10	12	11	82
Ice	124	15	36	15	190
Water	9	4	1	0	14
Slush	4	0	0	1	5
Snow	25	2	9	4	40
Wet	6	6	3	1	16
Other/Missing	2	1	1	1	5

RESULTS OF DATA ANALYSIS

Data from the crash reports were used to determine factors that contributed to the crash and to determine how the median affected the outcome of the crash. The study looked at the following contributing factors: action vehicle was performing, driver under the influence of drugs/alcohol, light condition of the roadway, surface condition of the roadway, and the human characteristics during the crash. Tables 3 to 5 present the cumulative results for the four highways analyzed in the study according to the contributing factors.

Table 3 shows the action the vehicle was performing at the time of the crash as well as the environmental factors and whether or not the driver was under the influence of alcohol or drugs. For action vehicle was performing, the top three factors were out of control (33.1%), traveling straight ahead (32.2%), and skidding (12.1%). Most of the crashes occurred during daylight conditions (51.1%) or on a lighted roadway (31.1%), which shows that non-lighted roadways are not a contributing factor to median crashes. Ice (53.7%), snow (11.3%), and dry (23.2%) pavement conditions were the top three factors related to surface conditions. Alcohol contributed between 8 and 11.0% of the crashes.

Table 4: First Sequence of Events

First Sequence of Events		**Rollover**		**Non-Rollover**		**Total Crashes**		
		Median	**Cross-over**	**Median**	**Cross-over**	**Rollover**	**Non-Rollover**	**Comb-ined**
Fixed Objects	Bridge Rail/Overpass	0	0	3	1	0	4	4
	Crash cushion/ Culvert/Curb/Wall	3	0	1	0	**3**	1	4
	Embankment	4	2	2	1	**6**	3	9
	Fence/Guardrail End/Face	7	0	8	6	7	14	21
	Light Support/ Sign/Tree	2	2	8	0	4	8	12
	Median Barrier	8	5	2	1	**13**	3	16
	Snow Berm	25	1	5	0	**26**	5	31
Action/Location	Cross Median/ Centerline/Head-on	5	7	4	14	12	18	30
	Ditch	56	7	9	4	**63**	13	76
	Overturn	46	6	1	0	**52**	1	53
	Ran Off-Road	61	9	17	4	**70**	21	91
	Immersion/Jackknife/ Other/Unknown	2	0	3	2	2	5	7
Total		219	39	63	33	258	96	354

Table 4 describes the first sequence of events of the crash. The first sequence of events is defined in the *Alaska Motor Vehicle Collision Report* (AMVC) as "the first injury or damage-producing event that characterizes the crash type" (*AMVC 2014*). The first sequence of events is divided into collision with a fixed object, and a particular action or the location of a crash. The three most frequent first sequences of events were Ran Off-road (25.7%), Ditch (21.5%), and Overturning (15.0%). Ditch is described in the *Collision Report* as "any man-made structure used for drainage purposes" (*AMVC 2014*). Overturn is synonymous with rollover and is described in the AMVC as a car rolling over at least a quarter turn. Snow berms accounted for 8.8% of median crashes, which APD also believed to be a contributing factor. A snow berm is a structure made of frozen snow, typically created by road maintenance crews when they plow the roads. Figure 2 shows what a snow berm looks like and how it can affect the outcome of a crash.

In Table 4, the bold values represent the first sequence of events with the highest frequency of rollover crashes. The events indicate that collision with crash cushion, culvert, curb, wall, embankments, median barriers, and snow berms were responsible for most rollover crashes when compared with non-rollover crashes. In terms of location, the most rollover crashes occurred in the ditch. Further, the action most responsible for rollover crashes were overturn and ran off-road crashes.

Table 5 indicates the human characteristics (or factors) that influenced the crash. Human characteristics, or the influence the driver had on creating the crash, included Unsafe Speed (22.9%), No Improper Driving (20.6%), and Driver Inexperience and Drove Off-road (10.2% each). For seventy-six crashes (21.4%), the contributing factor was either other, unknown or missing. Unsafe speed may not only be driving over the posted speed limit, it may also include driving faster than what road circumstances permit. For example, when the road is icy, drivers typically drive slower than the speed limit until road maintenance crews can sand or plow it. Driver inexperience can mean inexperience driving in general or inexperience in driving in icy/snow conditions. Since there is a military base on the outskirts of Anchorage, many out of state military men and women transfer from other states, some who may be inexperienced with driving in icy/snow conditions. The bold values in the table represent those human circumstances with the highest frequency of rollover crashes. It is clear that all behavior except driver illness, loss of consciousness, taking prescription medicine were greatly responsible for rollover crashes when compared to non-rollover crashes.

Table 5: Human Circumstances

Description	Rollover		Non Rollover		Total Crashes		
	Median	**Cross -over**	**Median**	**Cross -over**	**Rollover**	**Non Roll over**	**Comb -ined**
No Improper Driving	50	4	17	2	**54**	19	73
Driver Inattention	20	4	3	3	**24**	6	30
Driver Inexperience	24	3	6	3	**27**	9	36
Drove Off-road	17	4	10	5	**21**	15	36
Passenger Distraction/Fell Asleep	6	3	0	1	**9**	1	10
Illness/Loss of Consciousness/ Taking Prescription Meds	2	0	0	3	2	3	5
Following Too Closely/Improper Passing, Lane Usage/Change	4	1	1	0	**5**	1	6
Unsafe Speed	53	10	10	8	**63**	18	81
Other/Missing/Unknown	43	10	15	8	**53**	23	76

Figure 2. A vehicle rollover due to a snow berm

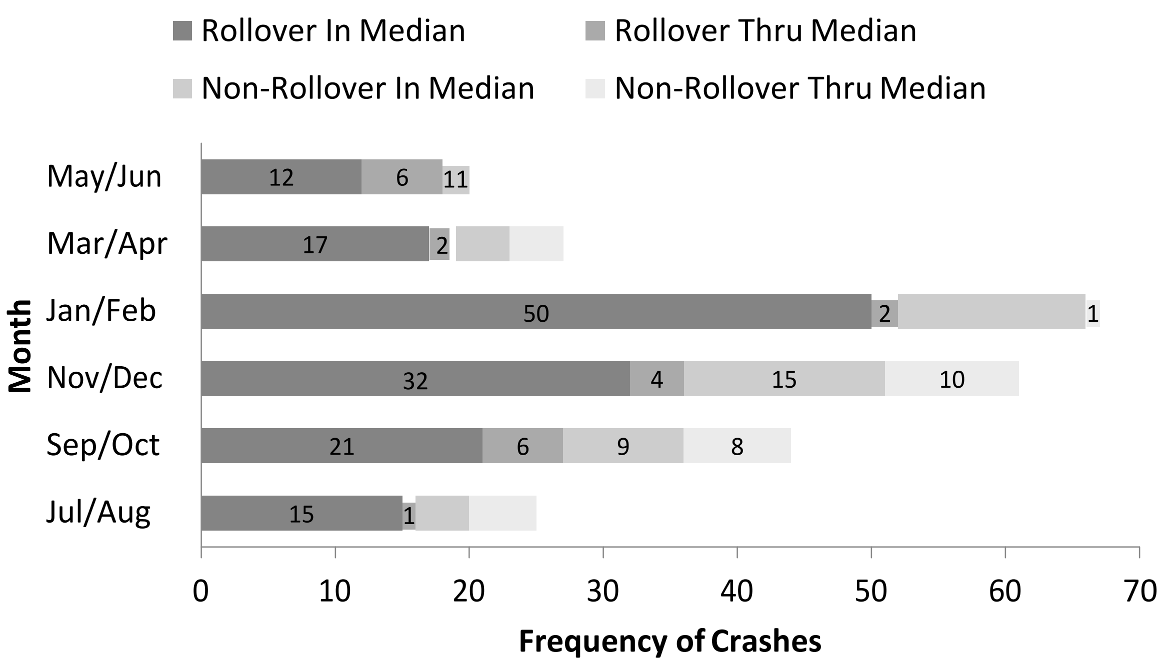

Figure 3. Crash Types per Two-Month Period on the Glenn Highway

While speaking with Sergeant Roy, it was indicated that snow berms and seasonal effects were important factors that contributed to crashes. Figure 3 presents the frequency of crashes separated by crash types (rollover and non-rollover) and location (median, crossover) as a function of time (per two-months) for the Glenn Highway. The Glenn Highway was chosen because it is responsible for 70.9% (251) of all crashes (354). It was observed that, January and February had the highest frequency of in-the-median crashes, while September through December had the highest number of crossover median crashes. From Figure 3 it is also evident that the crash frequency increases swiftly at the start of winter, peaks during January/February and then starts decreasing. The frequency of rollover in the median crashes also follows the same pattern.

DISCUSSION

From the results of the study, loss of traction appears to be the major contributing factor of median crashes in the Anchorage area. This can be seen in the high number of snow/icy road condition crashes as well as the out of control crashes and ran-off road. Unsafe speed could also play a role in the loss of traction, both when there’s snow and when the road is dry. The APD believes that vehicles running into snow berms cause a majority of the crashes, however this study found snow berms were linked with 8.8% of crashes. Since Alaska has one of the longest winter seasons in the country, driving in icy/snow conditions is something that every driver will need to be experienced in. Driver education in icy/snow conditions can help drivers with getting used to such driving conditions. Studded tires or winter tires and vehicles with all-wheel/four-wheel drive system can also help reduce such crashes.

Some of the countermeasures that were discussed with both AKDOT and APD were trying to plow the roads with a different shaped blade and adding cable barriers in the median. Before snow berms were thought to be an issue, the assumption was that the plows would cut into the median snow piles, essentially creating a wall of compacted snow. By changing the shape of the snow- plow, a different shaped snow berm would be created in the middle of the median, one that would possibly mitigate rollover crashes. Another idea that has been contemplating for a while is the addition of cable barriers down the centerline of the median. This would reduce the frequency of crossover crashes traversing through the medians when there is no snow. However, once the snowplows start pushing snow into the median, they would get covered and then it is not clear what their role will be.

The limitations of this study are underreporting of median crashes especially when vehicle damage is minimal. When a non-disabling property-damage only crash occurs, the driver is required to report the crash themselves to the Department of Motor Vehicles (DMV). Police reports are only written when the crash causes damage or injury, when the crash is involved in a crime, or the driver receives a citation. The Parks Highway only had 14 median related crashes, and Minnesota Drive had 29. This leaves the majority of the analysis to the two other highways, and may not represent the trends for the Parks Highway and Minnesota Drive. Since not all of the median crashes have police reports, only the disabling and injury related crashes are reported.

It is difficult to rate or analyze how well the median performed during the crash when mainly the most severe of crashes are analyzed.

CONCLUSIONS AND RECOMMENDATIONS

This preliminary study showed a number of contributing factors that did and did not affect median crashes. The time of year played a major role in median crashes. The highest median crash frequencies occurred between September and February. Ice and snow surface conditions accounted for 65% of crashes, which suggests that a lack of traction between the road and the tires is an issue. Ran-off the road and skidding were contributing factors, which also can be related to loss of traction. Two aspects this study identified was the number of snow berm related crashes and the number of crossover crashes in the summer was different than what was assumed by agencies. From analysis of five years of crash data for four different highways in Anchorage, 8.8% of the crashes had snow berms as the first sequence of event, which signifies there are other factors that affect median rollover crashes. The crossover crashes were assumed to occur mainly during the summer months, however September through December had the highest frequency of crossover crashes. Lack of snow within the median was thought to allow vehicles to traverse through the median, so the late fall/early winter months may have enough ice on the roads to lose traction, but not enough snow in the median to slow down the vehicle.

The results of this study are based on mainly preliminary analysis of data. The next steps for this study are to conduct a more detailed statistical analysis and to examine additional variables. A major challenge in this study is the small sample size for five years of crash data; commonly used statistical techniques require a much larger sample size. Another task to examine is the Computer-Aided Dispatch (CAD) information on PDO median crashes. With the CAD information and the video recordings, a total number of median crashes can be better estimated. Furthermore, additional variables to be examined are the slopes of the median, annual average daily traffic (AADT), gender, seat belt usage, age of the driver, times of the day, etc.

REFERENCES

AMVC (2014) Alaska Motor Vehicle Collision Report (12-200) Instruction Manual.

Donnell, E. T., Mason Jr., J. M. (2006) "Predicting the frequency of median barrier crashes on the Pennsylvania interstate highways." *Accident Analysis and Prevention*, 38, 590-599.

Graham, J.L., Harwood, D.W., Richard, K.R., O'Laughlin, M,K., Donnell, E.T., Brennan, S.N. (2014) "NCHRP Report 794: Median cross-section design for rural divided highways." *Transportation Research Board of the National Academies.*

Harwood, D.W., Gilmore, D.K., Graham, J.L., O'Laughlin, M.K., Smiley, A.M., Smahel, T.P. (2014) "NCHRP Report 790: Factors contributing to median encroachments and cross-median crashes." *Transportation Research Board of the National Academies.*

Hosseinpour, M., Yahaya, A. S., Sadullah, A. F. (2013) "Exploring the effects if roadway characteristics on the frequency and severity of head-on crashes: Case studies from Malaysian federal roads." *Accident Analysis and Prevention,* 62, 209-222.

Highway Safety Manual (2010) American Association of State Highway and Transportation Officials, AASHTO.
Hu, W., Donnell, E. T. (2010) "Median barrier crash severity: Some new insights." *Accident Analysis and Prevention*, 42, 1697-1704.
Hu, W., Donnell, E. T. (2011) "Severity models of cross-median and rollover crashes on rural divided highways in Pennsylvania." *Journal of Safety Research*, 42, 375-382.
Lane, P. l., McClafferty, K. J., Green, R. N., Nowak, E. S. (1995) "A study of injury producing crashes on median divided highways in southwestern Ontario." *Accident Analysis and Prevention*, 27(2), 175-184.
Lu, G., Chitturi, M. V., Ooms, A. W., Noyce, D. A. (2010) "Ordinal discrete choice analyses of Wisconsin cross-median crash severities." *Transportation Research Record: Journal of the Transportation Research Board*, 2148, 47-58.
Shankar, V. N., Albin, R. B., Milton, J. C., Mannering, F. L. (1998) "Evaluating median crossover likelihoods with clustered accident counts: An empirical inquiry using the random effects negative binomial model." *Transportation Research Record*, 1635. 44-48.