

Incorporating Incident Data into a Freeway Data Archive for Improved Performance Measurement

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ABSTRACT

The Portland Oregon Transportation Archive Listing (PORTAL) archives high resolution traffic data including speed, volume, and occupancy collected from 500 freeway loop detectors in the Portland metropolitan area. PORTAL currently provides measures related to total congestion that occurs on the freeway network, but cannot presently distinguish between recurrent and non-recurrent congestion effects. In response to the need to make such a distinction, the objective of this paper is to describe the incorporation of freeway incident data received from the Oregon Department of Transportation (ODOT) into PORTAL. ODOT's freeway incident database includes information about vehicle crashes and stalls, debris on the road, construction and other random events. The paper demonstrates how users can view incident data associated with a particular time frame and location. For example, a user analyzing data from a particular day will be able to immediately access associated incident data so the user can determine if the traffic pattern is related to an incident. In addition, freeway incident performance metrics will be described, including tracking of incident trends over time and location and numbers of incidents by incident type. Finally, the paper will describe how comparing incidents with weather data archived in the PORTAL database can be used to determine how weather has influenced incidents. The above-described incident performance metrics are useful to traffic researchers and practitioners and may contribute to incident-reduction measures in the Portland area.

INTRODUCTION

Non-recurrent congestion is congestion caused by incidents such as crashes, stalls, or special events. Researchers believe that approximately half of the delay experienced by travelers in the United States is due to non-recurrent congestion [1,2,3,4]. Further, the California Department of Transportation (Caltrans) estimates that for each minute an incident blocks a lane, approximately five minutes are added to the total time the freeway will be congested [5]. Understanding congestion is critical for traffic management operations in a metropolitan area such as Portland, Oregon. Improved information about non-recurrent congestion may improve incident response, improve travel time reliability, reduce secondary crashes, improve customer satisfaction and reduce overall congestion. Further, ITS researchers and practitioners need to be able to distinguish between recurrent and non-recurrent congestion for analysis purposes—for calculation of performance measures and for traffic pattern analysis. We have developed methods for cleaning, storing, and accessing ODOT incident data in an Intelligent Transportation Systems (ITS) data archive system and report on those methods and associated data analysis in this paper.

PORTAL SYSTEM

The Portland Transportation Archive Listing (PORTAL) [6,7] is the Portland metropolitan area's transportation data archive and is based on the Archived Data User Service (ADUS) framework [8] developed by the U.S. Department of Transportation (DOT) as part of the National ITS Architecture. PORTAL has been archiving speed, volume, and occupancy data from the loop detectors on the Portland metropolitan freeway system since July 2004 and has been designated by the Portland ITS and operations agencies as the official ITS data archiving entity for the Portland region. PORTAL receives a live stream of freeway loop detector data from the Oregon Department of Transportation (ODOT). This stream consists of 20-second volume, occupancy and speed measurements for nearly 500 freeway detectors in the metropolitan area. In addition to loop detector data, PORTAL archives weather data and now freeway incident data, as described in this paper. As suggested in the ITS Guidelines from the FHWA [9], user access to the PORTAL data archive is through a web-based interface providing easy access to both raw data sets and a wide range of common summary data and performance measures. Users have the option of graphically viewing data or outputting the data in tabular form. PORTAL's users include transportation planners, metropolitan planning organizations (MPOs), traffic management operators, transit operators, and transportation researchers.

DATA DESCRIPTION

The results in this paper are based on incident data from the ODOT Advanced Transportation Management System (ATMS) database. Incident data is entered into the ATMS database by operators at the ODOT Traffic Management Operations Center (TMOC). For each incident, operators create several entries in the database; entries are created when the incident is reported, when the status of the incident changes, and finally when the incident is cleared. Each entry has 92 fields including an incident identification that uniquely identifies each incident. Other fields include incident type, mode of detection, last update time, confirm time, primary route, secondary route, and number of lanes affected. Each of the 92 fields is included in each entry for each incident in the database; some of the fields change from entry to entry – for example, the number of lanes affected by an incident may change as an incident is cleared from the mainline highway lanes to the shoulder; while other fields remain relatively static such as confirm time and location information.

To make the incident data suitable for analysis the multiple database entries for each incident must be combined into one incident record providing location, duration and other important parameters for that incident. For the remainder of this paper, we use the word *entry* to refer to an incident entry in the ATMS database and the word *record* to refer to the single incident record that we derive from the incident entries. Finally, since the incident information is entered by human operators in a real time, management center environment, it must be cleaned—for example, inconsistent route names must be standardized. We proceed to describe how we address these issues.

DATA AGGREGATION AND CLEANING

The ODOT ATMS incident database contains multiple entries for each incident; one of the biggest challenges in dealing with this data lies in determining how to merge these multiple entries to create one record per incident. We describe the derivation of several fields in the incident record from the incident entries. Recall that an entry is made the incident status changes. The fields in incident records are similar to those in incident entries; some major differences are that incident records contain duration information, a flag for those incidents not located, and a standard way to represent the freeways. We describe the creation of several important fields in the incident records, beginning with the duration field.

To determine the duration of an incident, we derive estimates for the incident start and end time from the ATMS database, as follows. The ATMS database contains two types of time information. First, each entry in the database contains a "last update time" that specifies the time associated with that entry; recall that an incident entry is created each time the status of an incident changes. Second, most incidents have a "confirm time" that indicates the time that an ODOT operator was able to confirm that a reported incident actually occurred. For incidents that have a confirm time, we use that time as the start time; for those that do not, we use the time of the first entry in the ATMS database. For most incidents, the final entry is an entry indicating that the incident has been cleared; therefore, we use the time of the final entry for an incident as the incident's end time. Though rare, there are times an incident is opened later or even kept open until the next day, thus having a "last update time" that is much later than the actual end time. By searching the table for incidents with large durations, we can examine entries that might be affected by this problem. By subtracting the end time from the start time, we obtain a reasonable estimate of the duration of the incident.

In some cases, an incident is reported to ODOT, but ODOT TMOC operators are unable to locate the incident. In this case, the operator will often enter "UTL" (Unable To Locate) in the comment field in the incident entry. By searching comment fields in incident entries for "UTL" we can identify most of the incidents that were never located. Incident records are created for un-located (UTL) incidents, but are flagged in the database and are not included in our analysis at this time.

Several fields in the incident entries (in the ATMS database) are used to indicate whether a particular action occurred or not; for example, to indicate if police responded or if there was light pole damage. We call such fields flag fields; a flag is set if the action occurred. If any entry for a given incident has such a flag set, then the derived incident record for that incident shows the flag set. For instance, if the first entry for an incident shows no police response, but the second entry does, the final record will show that there was a police response for this incident.

Incident entries contain a field to indicate the impact of an incident on traffic. The impact level may vary over the course of an incident; as a result, different entries for a single incident may have different impact levels. The incident impact options are: no impact, low impact, medium impact, high impact, and unknown impact. The incident

record contains the highest impact level from the multiple incident entries. Similarly, incident entries contain lane location information (i.e. all lanes, left lanes, shoulder, gore area). Different entries for an incident may have different values for the lanes location. The incident record contains the most severe lane impact of all the incident entries.

Our derived incident records contain a field for the highway on which the incident occurred. Deriving this field was challenging because ODOT operators hand-enter the name of the primary route on which the incident occurred, causing inconsistencies in how highways are referred to. For example, "I-84" can be written a number of ways such as "I-84," "i84," "84", etc. In addition, one highway in Portland has several names, adding more complexity. Further, the primary route is sometimes not labeled by the highway at all, but instead by the bridge name for that section of the highway. To address this issue, we compiled a list of alternative names for each highway and we compare the "primary route" field in the incident entries to the list of alternative names. When a match is found, we can associate a highway with an incident. Incident entries also contain a field indicating the direction of the highway. We use both of these pieces of information to create a "highwayid" field in the derived incident record. The highwayid links the incident record to highway and direction information in the PORTAL database; having this link makes it straightforward to associate the incident data with other PORTAL data.

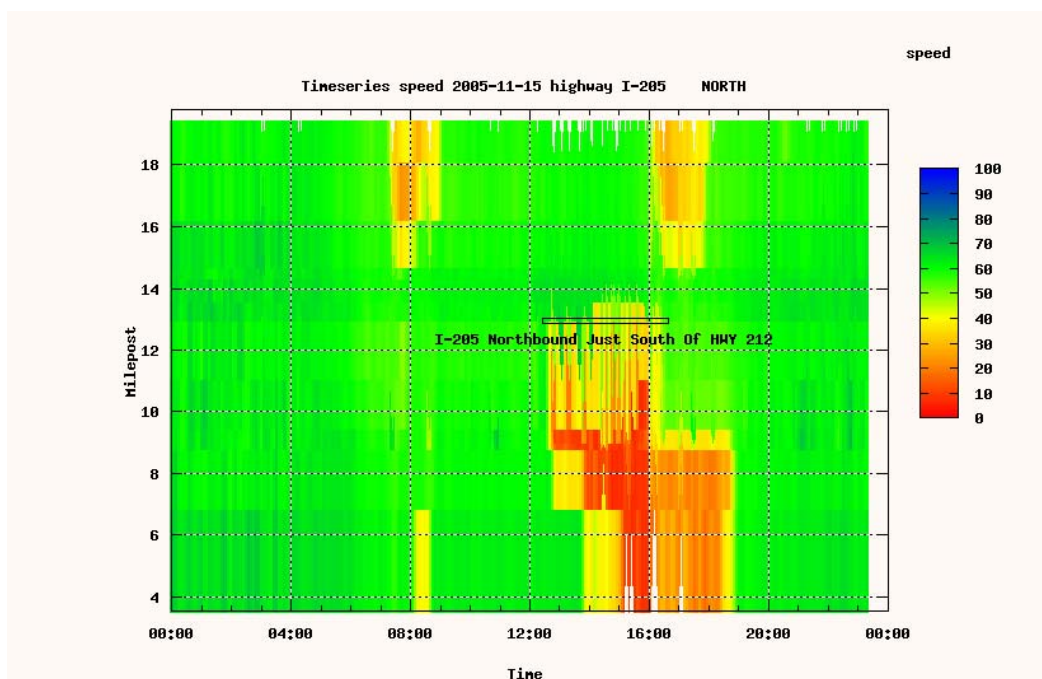


Figure 1: Display of Incident Location and Duration in PORTAL

INCIDENT DATA DISPLAY IN PORTAL

Figure 1 shows a plot of speeds on highway I-205 North on November 15, 2005. Traffic travels "upward" on the graph, from milepost 4 at the bottom of the graph to milepost 18 near the top. Green colors indicate freely flowing traffic; yellow and red indicate congestion. The figure shows normal rush hour congestion around mileposts 4-8 and

15-19 in the morning and evening peaks. However, the reduced speeds shown starting shortly after noon are not typical. The horizontal bar in the graph represents an incident that occurred near milepost 13 which began shortly after noon and ended shortly after 4. It is clear that the slower traffic was due to this incident. Displaying incident data on speed plots can be used to better understand traffic patterns.

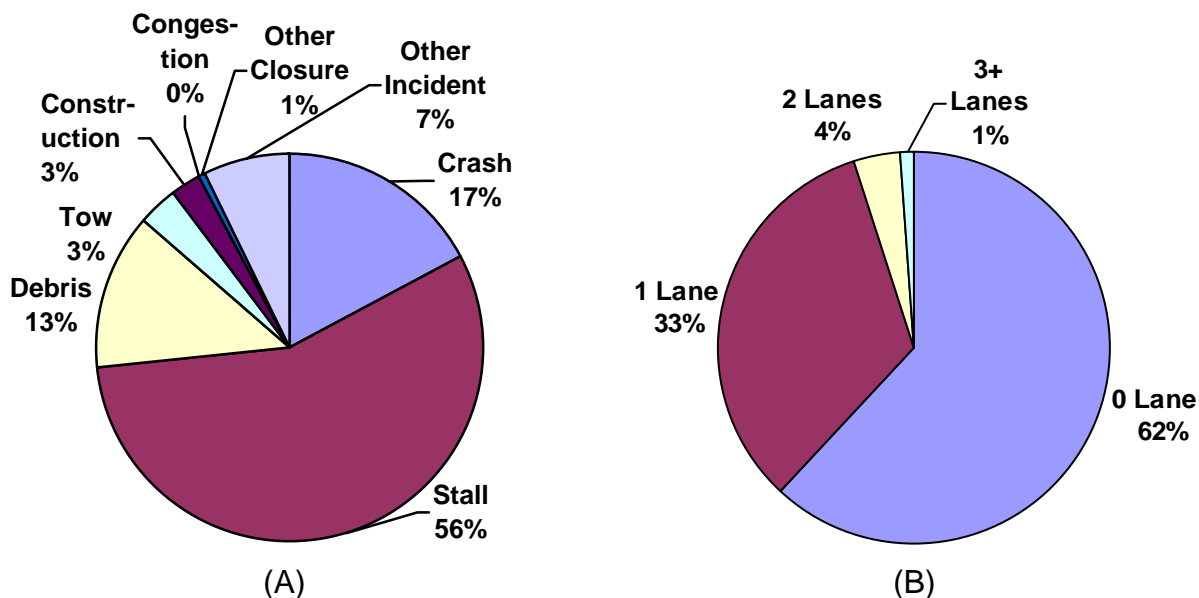


Figure 2: Incidents by Type (A) and Number of Lanes Affected (B) (N=17,885)

ANALYSIS OF INCIDENT DATA

In 2005, the ATMS database identified 17,885 located incidents; we show several figures breaking down these incidents by type, lanes affected, location, and correlation with precipitation. This type of information is useful for incident management.

Figure 2 (A) shows the percentage of incidents of different types in 2005. We note that over half (56%) of the incidents were stalls. The next most common types of incidents were crashes (17%) and debris (13%). Tows, construction, congestion, other closures, and other incidents together accounted for 14% of all incidents. Figure 2 (B) shows incidents broken down by the number of affected lanes for the year 2005. (Recall that the number of affected lanes is the maximum number of lanes the incident blocked during its duration.) A full 62% of incidents did not block any lanes; this observation is likely related to the high occurrence of stalls as show in Figure 2 (A). Finally, we note that only 5% of incidents blocked two or more lanes.

Figure 3 breaks down incidents by affected lanes. We note that 44% of incidents affect only the right shoulder; this is consistent with a high percentage of incidents being stalls. Further, we note that more than half of the incidents had no affect on any lanes and only 36% of incidents were known to affect the travel lanes of the freeways.

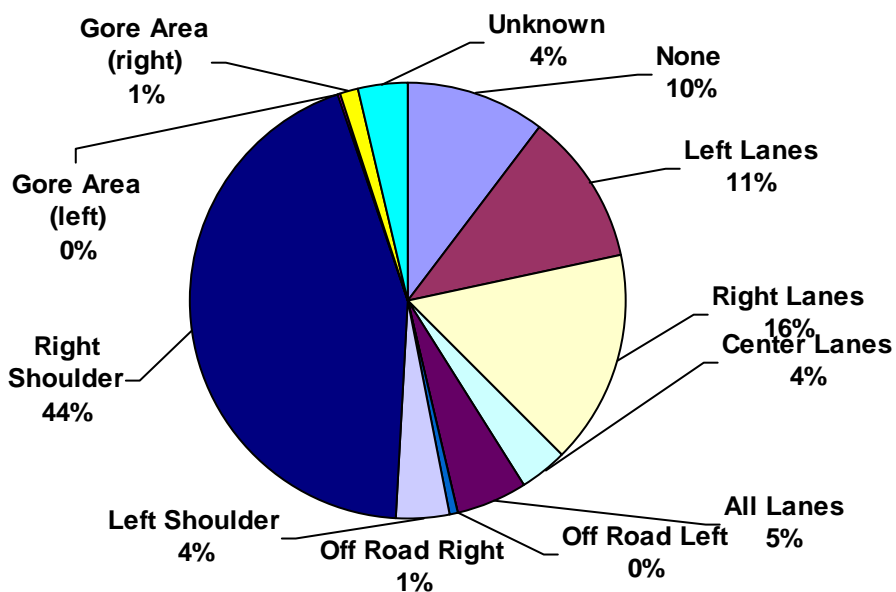
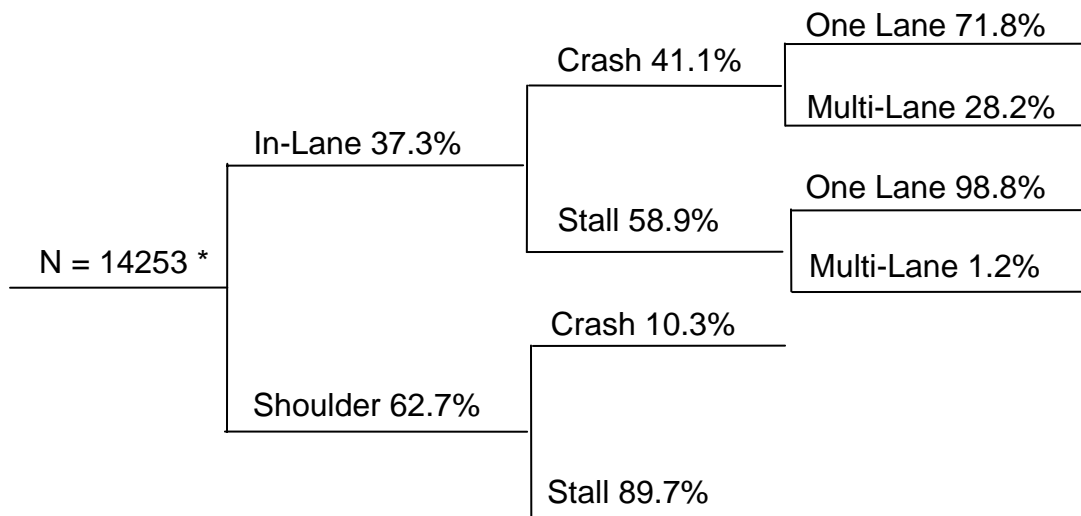


Figure 3: Incidents by Location (N = 17,855)



* Incidents with complete lane location data

Figure 4: Incident Tree 2005

Figure 4 shows an incident tree depicting the breakdown of incidents by lane location. Out of the incidents with complete lane location data, more than half (62.7%) occurred only in shoulder areas. Of these, most (89.7%) were stalls. A small number (10.3%), however, were crashes. Of those incidents that occurred in lanes, 58.9% were stalls. This is still over half, but a smaller percentage than those that only occurred in shoulder areas. Most of the stalls that occurred in lanes (98.8%) affected only one lane. However, there was a small percentage (1.2%) that affected multiple lanes. For crashes that occurred in the freeway lanes, more than half (71.8%) occurred

in only lane only. Those crashes affecting multiple lanes were at 28.2% - higher than the percentage of stalls affecting multiple lanes. This is logical considering stalls tend to involve only one vehicle, while crashes often include multiple vehicles.

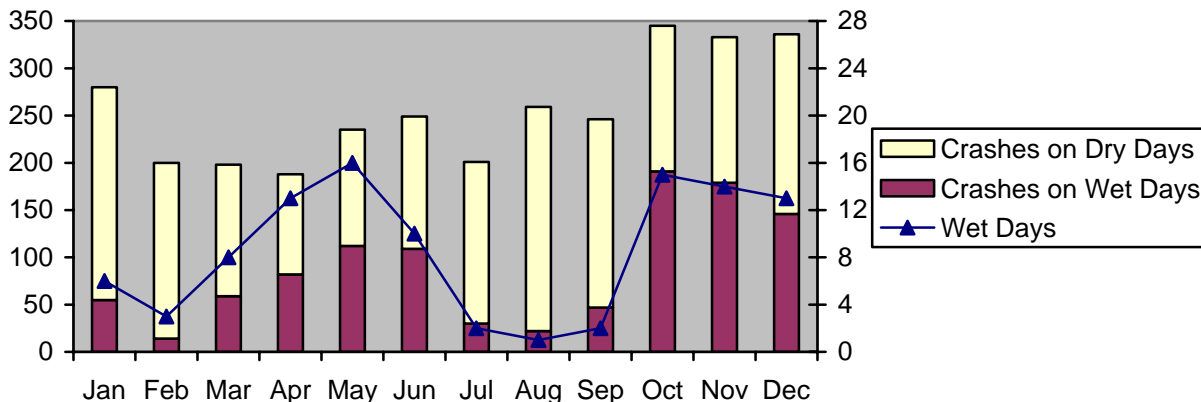


Figure 5: Crashes and Precipitation

Figure 5 compares the number of crashes on wet and dry days to the number of wet days for each month in 2005. Weather data was obtained from PORTAL; days with total measured rainfall greater than .05" were considered wet days. In general, the highest number of crashes occurs during the rainy months; however, the month of May exhibits a large number of wet days, but fewer crashes than other rainy months. We also note that January through March 2005 was unusually dry in the Portland region.

CONCLUSIONS

We have described an automated data cleaning and aggregation process for incident data from the ODOT ATMS database. By automating the data cleaning, we are able to quickly produce incident records from ATMS database incident entries, which are stored in the PORTAL data archive. Having such incident records in PORTAL allows incident statistics to be generated with minimal effort. In addition, we can easily access the incidents for a particular freeway during a time interval so that traffic patterns can be compared with associated incident data. In particular, we have demonstrated how incidents can be displayed on speed contour plots to allow users to distinguish between recurrent and non-recurrent congestion. Finally, since PORTAL archives weather data, weather conditions can be easily compared to incident records. Our flexible, automatic incident cleaning and archive technology provides a new and useful tool to traffic practitioners and researchers.

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