

METAVERSE

CE 784A : Initial Results: Semester 2021-22 (II)

Traffic Incident Duration Analysis and Prediction

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Turnitin accuracy: 13%
[Github repository](#)

1. Terms:

- Speed: The detector's detection speed.
- Flow: This is the number of automobiles per granularity time period. The granularity can be changed by the user and runs from 5 minutes to one month. The depicted flow figures are the total over the unit of granularity..
- Occupancy: The amount of time the detector is turned on.
- Travel Time Index: This is the ratio of the free-flow trip time to the average journey time for all users in a region. The free-flow travel speed is assumed to be 60 miles per hour.
- Vehicle Hours Traveled(VHT): The total amount of time spent on the freeway by all vehicles. This number is simply the sum of the VHT from the individual detectors when plotted over spatial regions.
- Vehicle Miles Traveled(VMT): For that geographical region, the total miles driven by the cars during that time period. This amount is simply the sum of the VMT from the individual detectors when plotted over spatial regions.
- Postmile (Abs): Absolute postmiles reflect the exact distance traveled along a freeway from start to finish.
- Delay: This is the time spent by all vehicles over and above the time required to transit a link at a threshold speed. We calculate the value of delay for a variety of threshold speeds that can be selected from the drop-down menu.
- Q(VMT/VHT): This is calculated by dividing the sum of the VMT in a region by the sum of the VHT in the same region. It's the speed for a single detector. It is a measure of the transportation system's efficiency over time for a region.
- Bottleneck: A bottleneck occurs when traffic demand surpasses the roadway facility's available capacity. Reduced speeds, congestion, queuing, and delay are all characteristics.

2. Initial Results

For the initial study of data, the data extracted from Caltrans PeMS has been used. We have compiled our results for a specific freeway I10-W.

Fig 2.1 represents the plot between the total number of incidents that took place in the year 2021 on freeway I10-W.

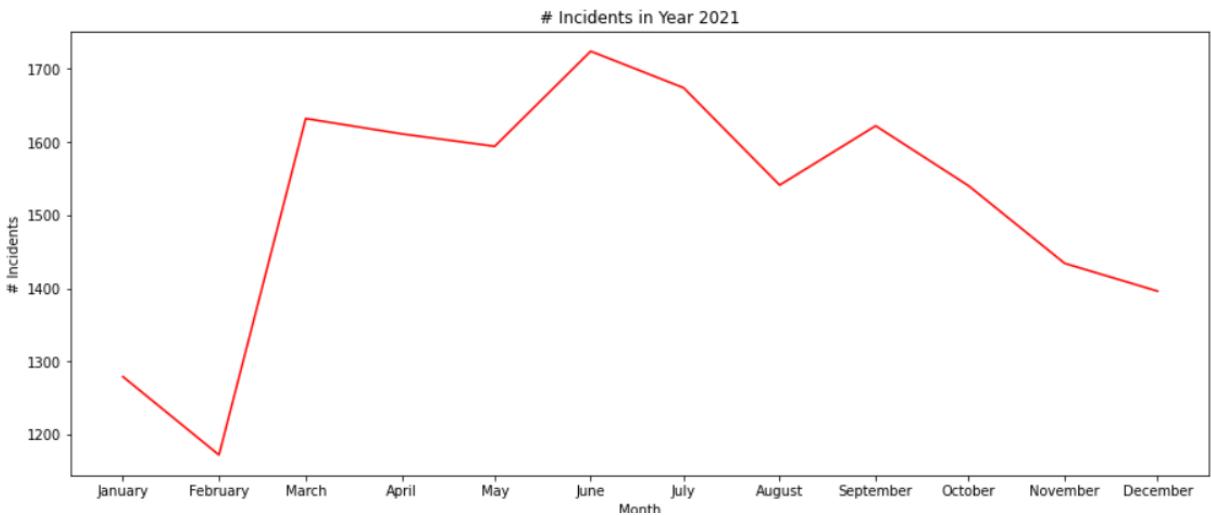


Fig 2.1: Number of Incidents in the Year 2021

From Fig 2.1, the maximum number of incidents that took place in the calendar year 2021 was in the month of June while the minimum was for the month of Feb.

For this study, we have chosen Feb Month at random to do the microscopic study and interpret how factors such as speed, flow, occupancy, delay, time of day, vehicle miles traveled, vehicle hours traveled, Q(VMT/VHT), travel time index, Bottleneck etc, affect the incident duration.

Initially, we scrolled through the analysis on 12 Feb 2021 and view the incident duration analysis. We ended the study by analyzing the whole month Feb and interpret how the above factors affect the incident.

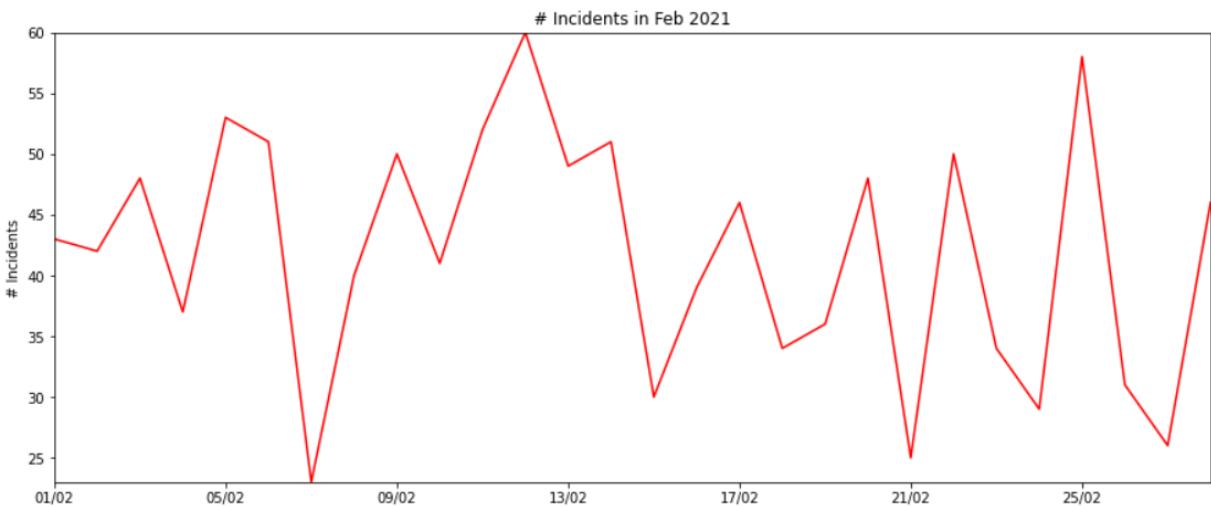


Fig 2.2: Number of Incidents in Feb 2021

Considering the month of Feb in the year 2021, from the Fig 2.2 of the number of incidents, the maximum number of incidents had occurred on 12th Feb; thus, for further analysis, this date was used, and Fig 2.3. represents a part of the incident details for the 12th Feb 2021.

	Incident Id	Start Time	Duration (mins)	Freeway	CA PM	Abs PM	Source	AREA	LOCATION	DESCRIPTION
0	19988509	02-12-21 02:12	10	I10-W	R10.455	8.3	CHP	Central LA	I10 W - S La Brea Ave	FIRE-Report of Fire
1	19988621	02-12-21 05:49	58	I10-W	29.5	28.0	CHP	East LA	I10 W - Valley Blvd	1179-Trfc Collision-1141 Enrt
2	19988652	02-12-21 06:18	0	I10-W	29.439	76.2	CHP	San Bernardino	I10 W Eo - Alabama St	1125-Traffic Hazard
3	19988680	02-12-21 06:43	36	I10-W	27.7	26.2	CHP	East LA	I10 W - Temple City Blvd	1125-Traffic Hazard
4	19988688	02-12-21 06:45	19	I10-W	27.7	26.2	CHP	LAFSP	I10 W - Temple City Blvd	1125-Traffic Hazard
5	19988699	02-12-21 06:50	0	I10-W	16.228	63.0	CHP	San Bernardino	I10 W - Sierra Ave Onr	1125-Traffic Hazard
6	19988706	02-12-21 06:57	11	I10-W	29.3	27.8	CHP	LAFSP	PECK RD ONR - I10 W	1125-Traffic Hazard
7	19988736	02-12-21 07:19	12	I10-W	R18.528	65.3	CHP	San Bernardino	I10 W - Cedar Ave	1125-Traffic Hazard
8	19988737	02-12-21 07:18	0	I10-W	R18.528	65.3	CHP	San Bernardino FSP	I10 W - Cedar Ave	1125-Traffic Hazard
9	19988758	02-12-21 07:28	14	I10-W	15.828	62.6	CHP	San Bernardino FSP	Sierra Ave Onr - I10 W	1125-Traffic Hazard
10	19988759	02-12-21 07:27	15	I10-W	15.828	62.6	CHP	Rancho Cucamonga	Sierra Ave Onr - I10 W	1125-Traffic Hazard
11	19988999	02-12-21 09:19	16	I10-W	10.635	57.4	CHP	Rancho Cucamonga	I10 W Eo - I15	1125-Traffic Hazard
12	19989024	02-12-21 09:36	0	I10-W	1.535	48.3	CHP	San Bernardino FSP	I10 W Eo - Central Ave	1125-Traffic Hazard
13	19989025	02-12-21 09:35	10	I10-W	1.535	48.3	CHP	Rancho Cucamonga	I10 W Eo - Central Ave	1125-Traffic Hazard

Fig 2.3: Representation of Incident Details for 12 Feb 2021
(Only a few rows are shown)

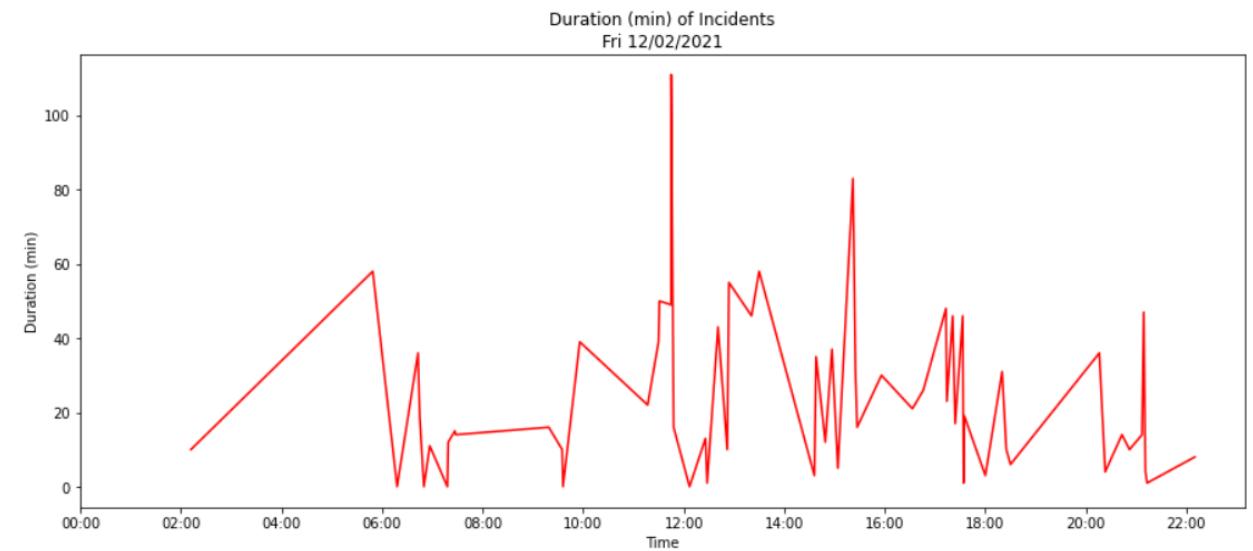


Fig 2.4: Duration (min) of Incidents

From Fig 2.4, We observed that the incident duration is more from 10 am to 4 pm and gets a maximum value of around noon. We infer that most incidents took place during the daytime.

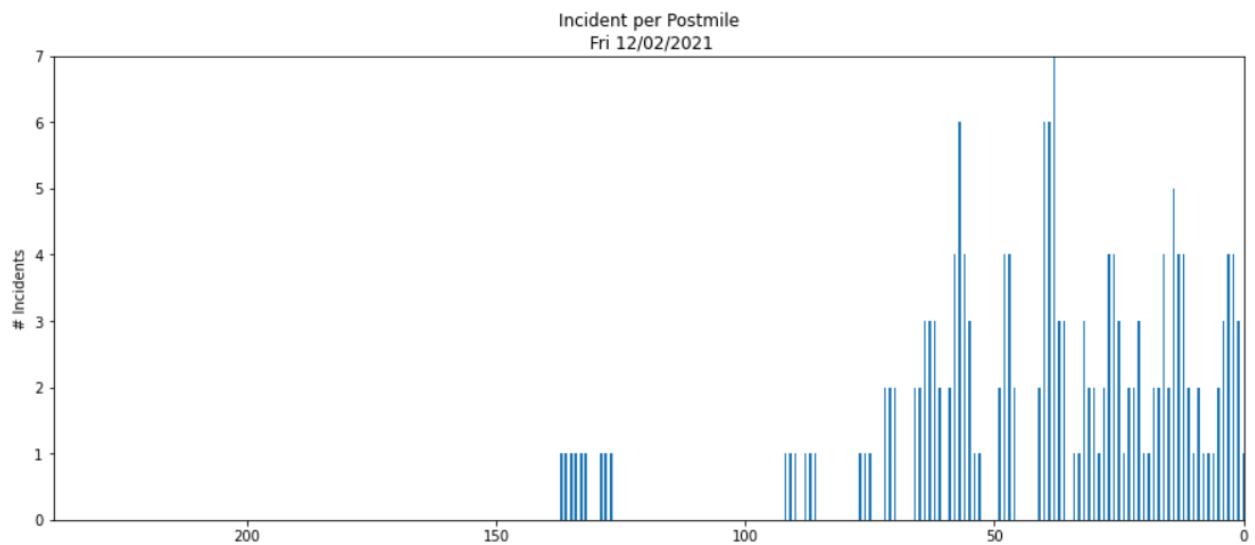


Fig 2.5: Incident per postmile

Fig 2.5 shows incidents per postmile. We inferred that maximum incidents occurred from 0 to 70 postmile length of freeway.

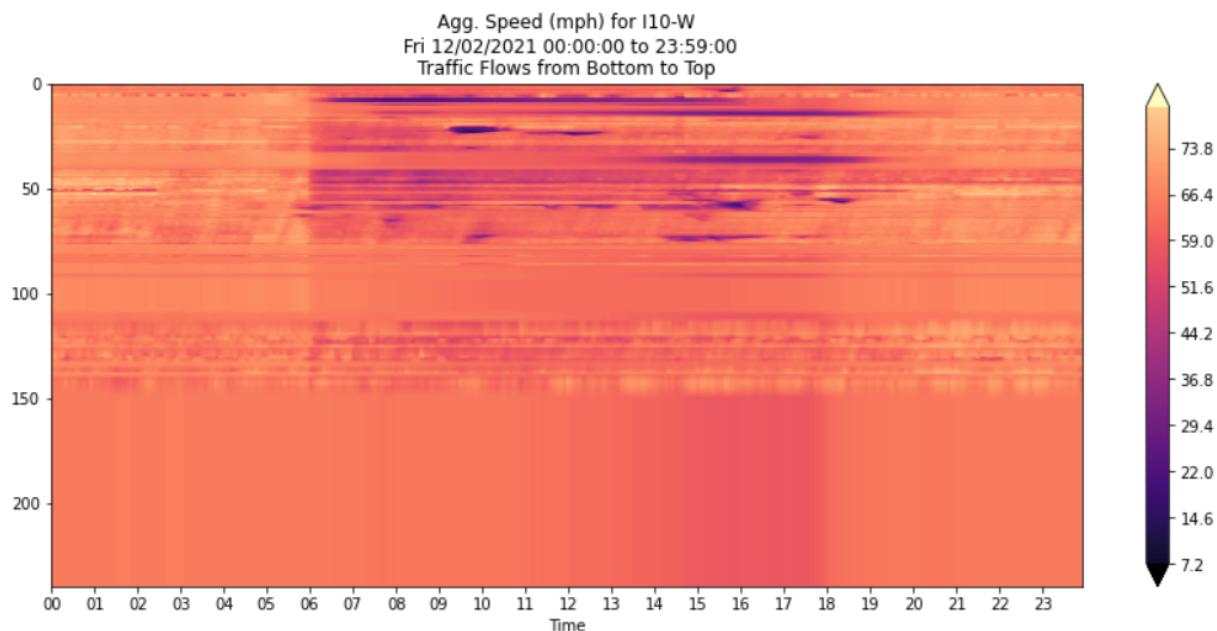


Fig 2.6: Agg. Speed (mph) for 12 Feb 2021

Fig 2.6 shows the aggregated speed of all lanes for the I10-W freeway on 12th Feb from 00:00 to 23:59. We observed that speed decreases from 7:00 to 19:00 hours. We also watched that incidents occurred from around the 5th postmile to 70 postmile. Whenever an incident takes place, speed decreases and incident duration increases, and it also affects the post mile length, which results in congestion.

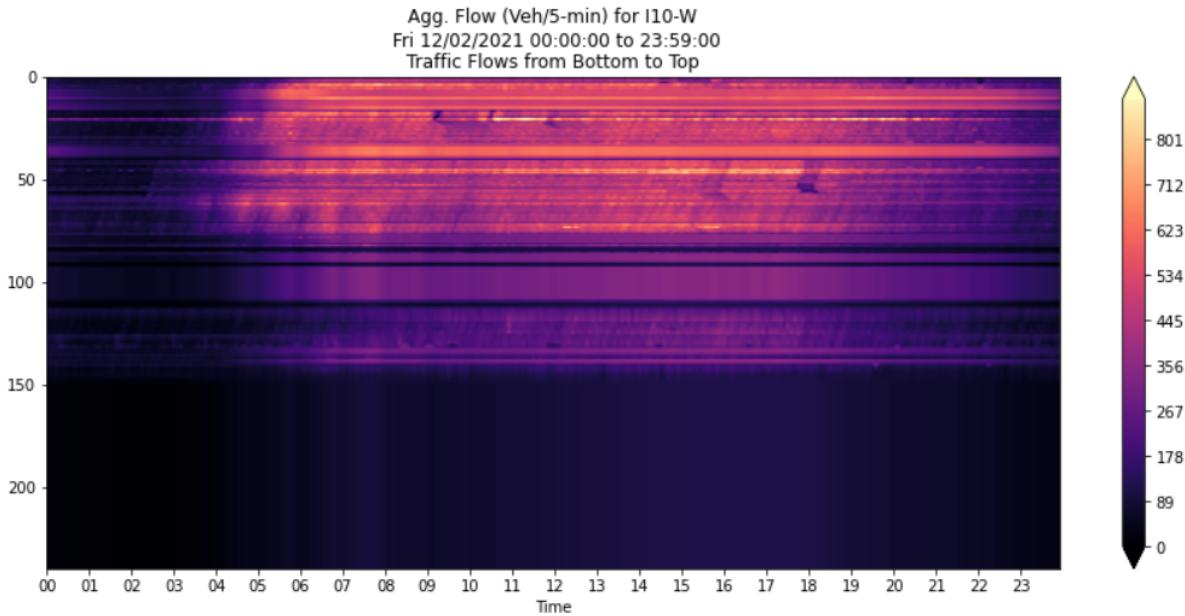


Fig 2.7: Agg. Flow (Veh/5-min) for 12 Feb 2021

Fig 2.7 shows aggregated flows for 12th Feb; flow is highest from 6 am to 8 pm; here, we saw that if an incident takes place on a freeway, then avg speed of the traffic flow will decrease, which will lead to congestion in a flow which eventually causes an increase in flow.

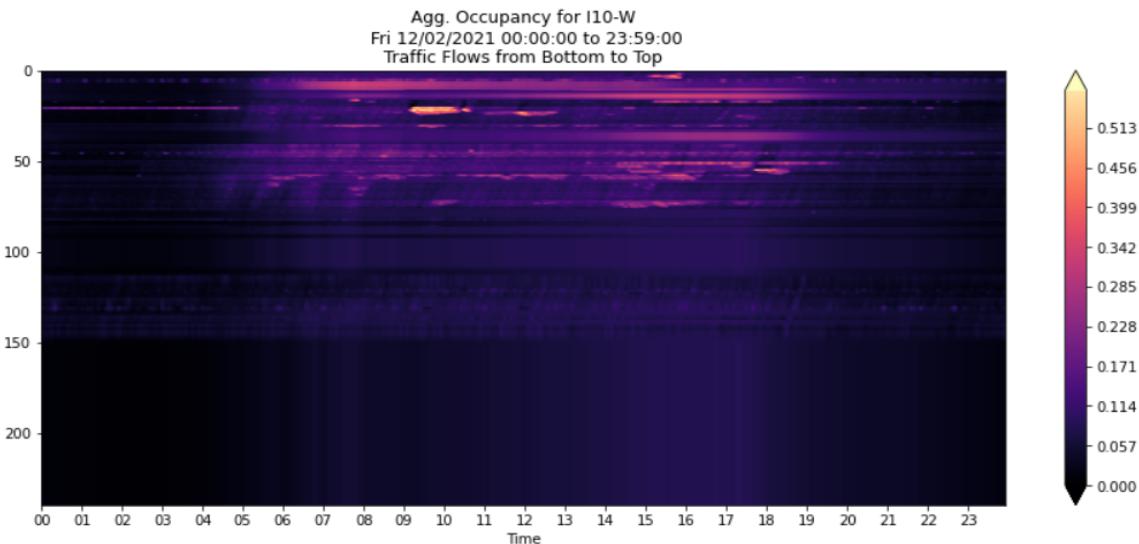


Fig 2.8: Agg Occupancy for 12 Feb 2021

Fig 2.8 shows the average occupancy for 12th Feb from 00:00 to 23:59. Again we saw that occupancy increases with incidents. From the graph, we inferred that occupancy is highest from 9 to 11 am, and from Fig 2.3, we observed the same thing as traffic hazards took place in the same time zone.

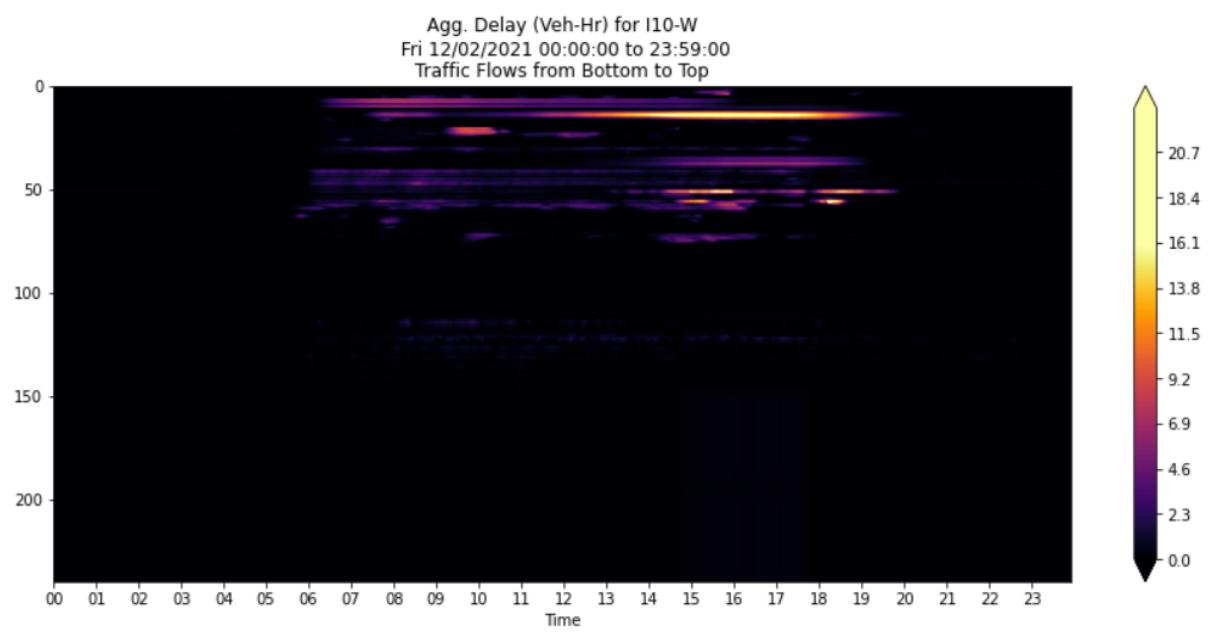


Fig 2.9: Agg Delay for 12 Feb 2021

From Fig 2.9, we saw that as incidents occur, the flow's speed slows down, which leads to delays for the vehicles, and we also interpreted that more aggregate delay will be the incident duration.

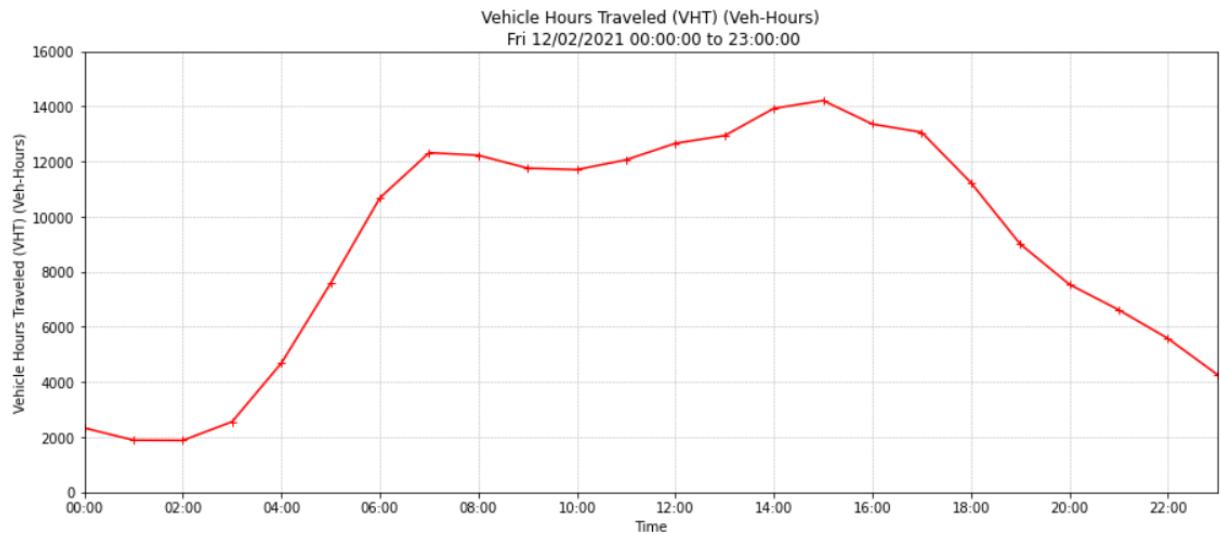


Fig 2.10: Vehicle Hours Traveled (VHT) for 12 Feb 2021

From the plot of Vehicle Hours Traveled (VHT) (Veh-Hours) against the time of the day (Fig 2.10) for the 12th Feb 2021, it can be interpreted that as the incidents took place, the average speed of the flow slowed down, thereby increasing the total time taken by vehicles to cross the entire length of the freeway. Thus it can be said that incident duration depends on VHT such that the more the VHT, the more will be the incident duration.

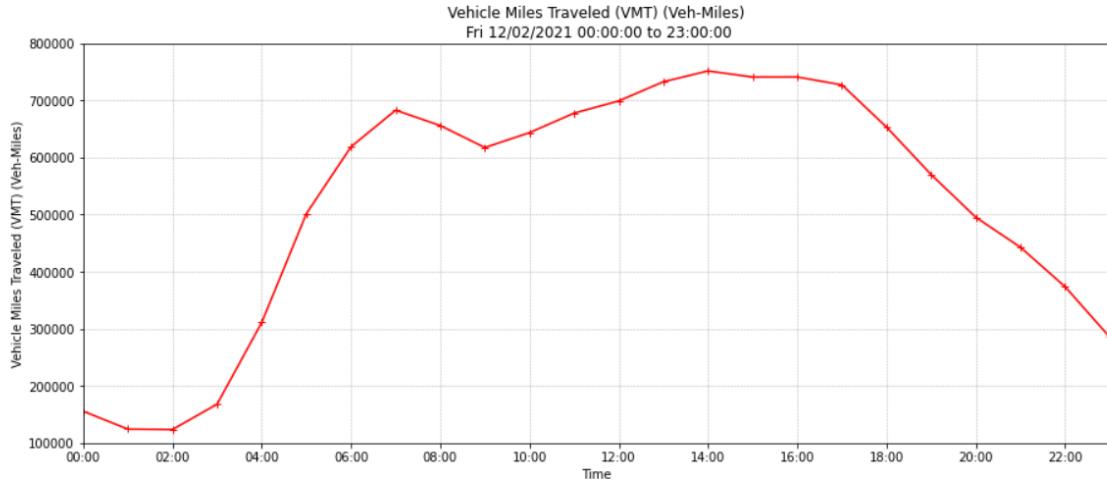


Fig 2.11: Vehicle Miles Traveled (VMT) for 12 Feb 2021

The plot of vehicle miles traveled (VMT) (Fig 2.11) can be interpreted as the same as VHT. So, it can be said that incident duration will increase with an increase in VMT.

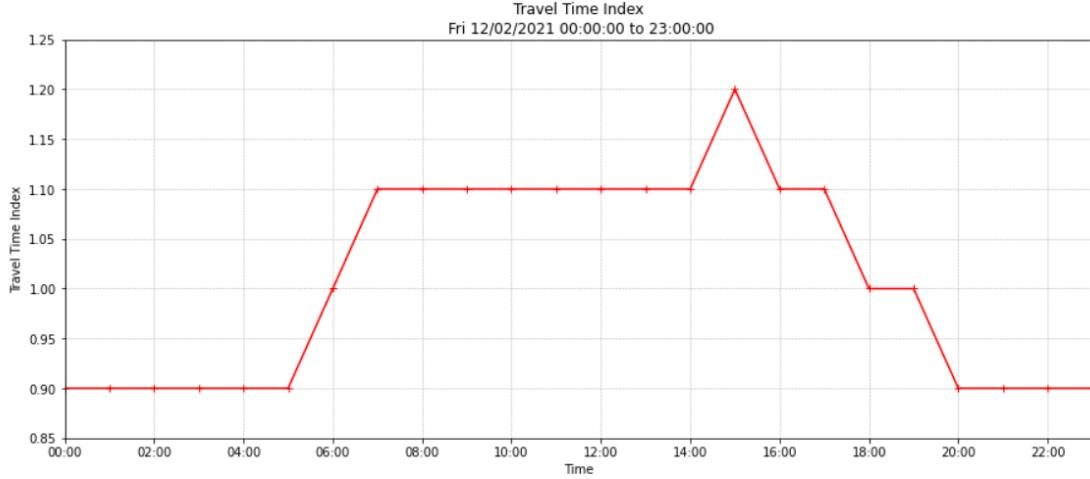


Fig 2.12: Travel Time Index for 12 Feb 2021

The travel time index is the ratio of the average journey time for all users across a region to the free-flow travel time. The free-flow travel speed is expected to be 60 miles per hour, as seen in Fig. 2.12. As events occur, the average travel time for cars increases, increasing the travel time index.

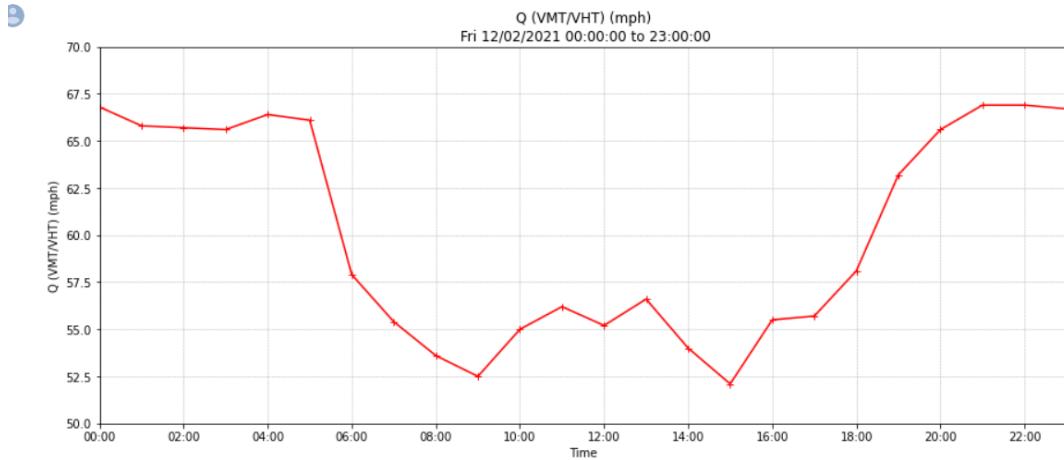


Fig 2.13: Q(VMT/VHT) (mph) for 12 Feb 2021

The Q is calculated by the ratio of the sum of the VMT in a region by the sum of the VHT in the same region. It is thus a measure of the transportation system's efficiency over time for a region.

From Fig 2.13, we inferred that the system's efficiency would decrease with incident duration, provided there is no increase in incidents.

From Fig 2.13, it is observed that Q decreases with an increase in incident duration. From Fig 2.4, we observed that incident durations are more concentrated from 07:00 to 19:00 hours. Here, the graph is inversely plotted, which means the incident has a negative impact on Q.

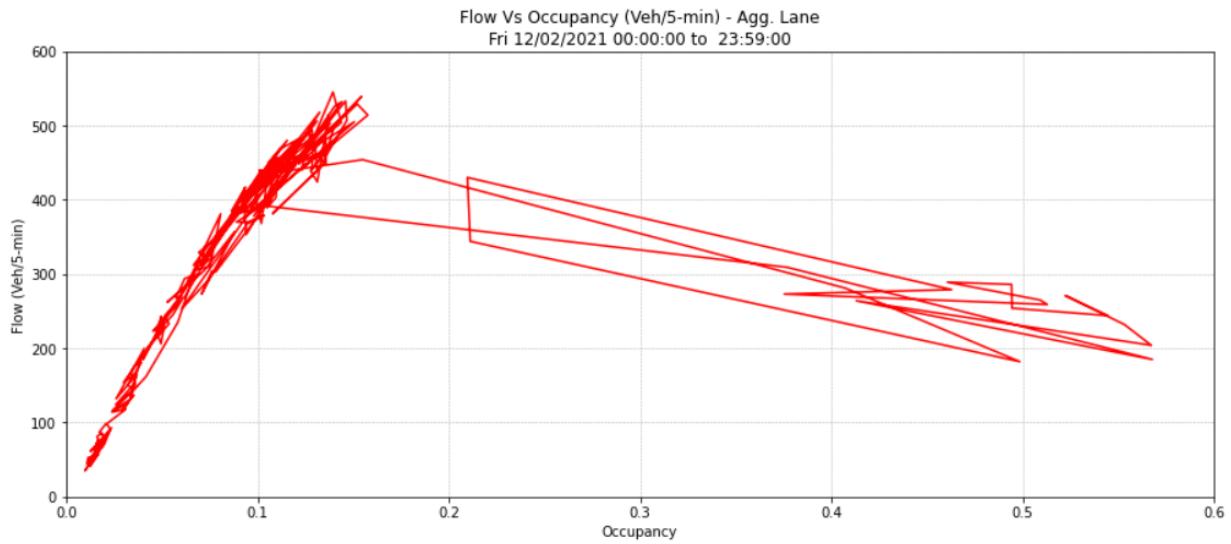


Fig 2.14: Occupancy vs Flow (Veh/5-min) for 12 Feb 2021

Fig 2.14 shows the fundamental relation between the flow and occupancy. Initially, flow increases with increased occupancy as the occupancy is the measure of the freeway covered by the vehicles. After reaching the maximum

observed flow, the flow breaks down as the occupancy increases because the traffic flow becomes more congested, eventually decreasing the flow's efficiency.

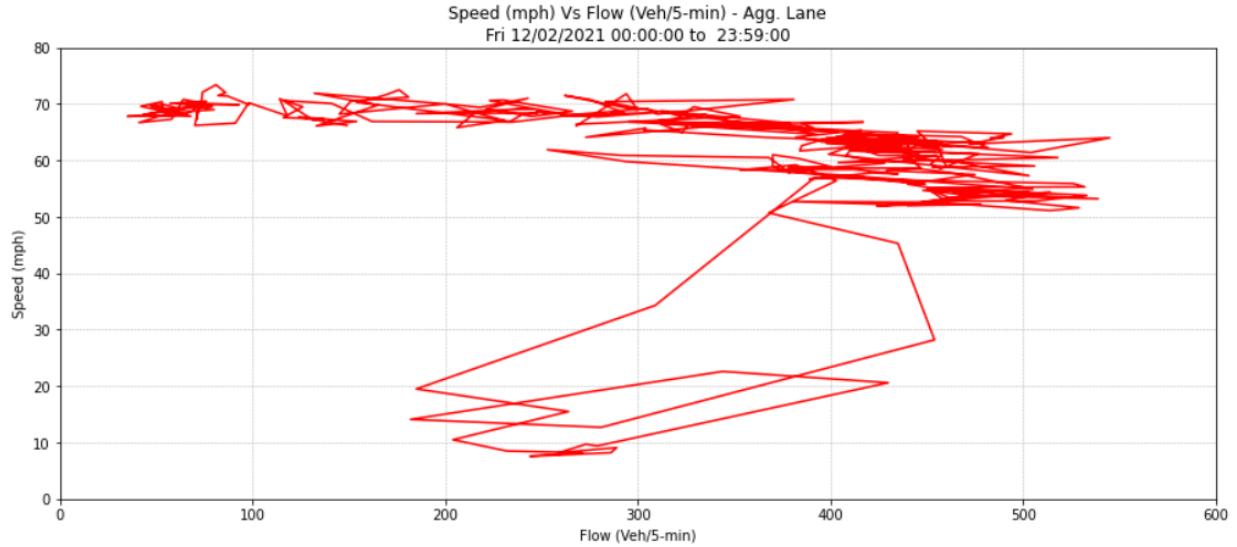


Fig 2.15: Speed (mph) vs Flow (Veh/5-min) for 12 Feb 2021

Another fundamental relation is the plot between the speed and the flow. The flow initially increases with the increase in speed and reaches the maximum value at the highest speed. Then, speed decreases as flow decrease, illustrated in Fig 2.15. From the plot, we can infer that flow and speed drop during congestion.

Now, we scaled our analysis to the whole month of Feb. Further study is as follows:

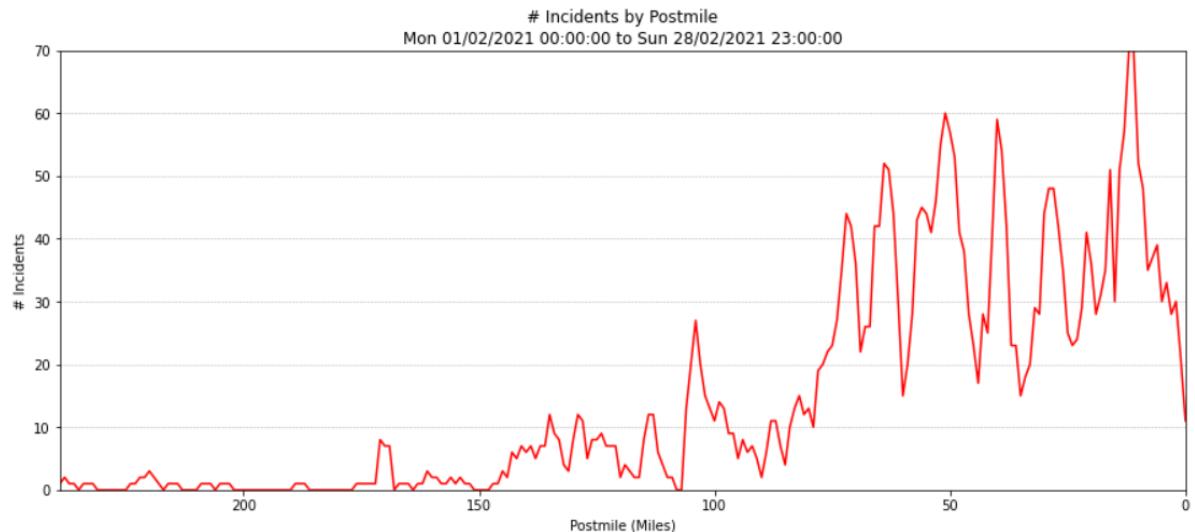


Fig 2.16: Number of Incidents by Postmile for the month of Feb 2021

Incidents by Postmile graph helps us visualize the number of incidents in Feb 2021 and as in Fig 2.16. we noticed that more incidents had occurred between 100 to 0 postmiles. This suggests that there are some peculiars with these postmiles and hence the chances of an incident happening between these are more than the other.

Similarly, suppose we checked the contour plot for the aggregated speed for the I10-W freeway from Fig 2.17. In that case, we inferred that the speed decreases a lot in the region around 100 to 0 postmiles which from Fig 2.16 is more evident as we have seen earlier; hence, the number of incidents directly impacts the vehicle's speed.

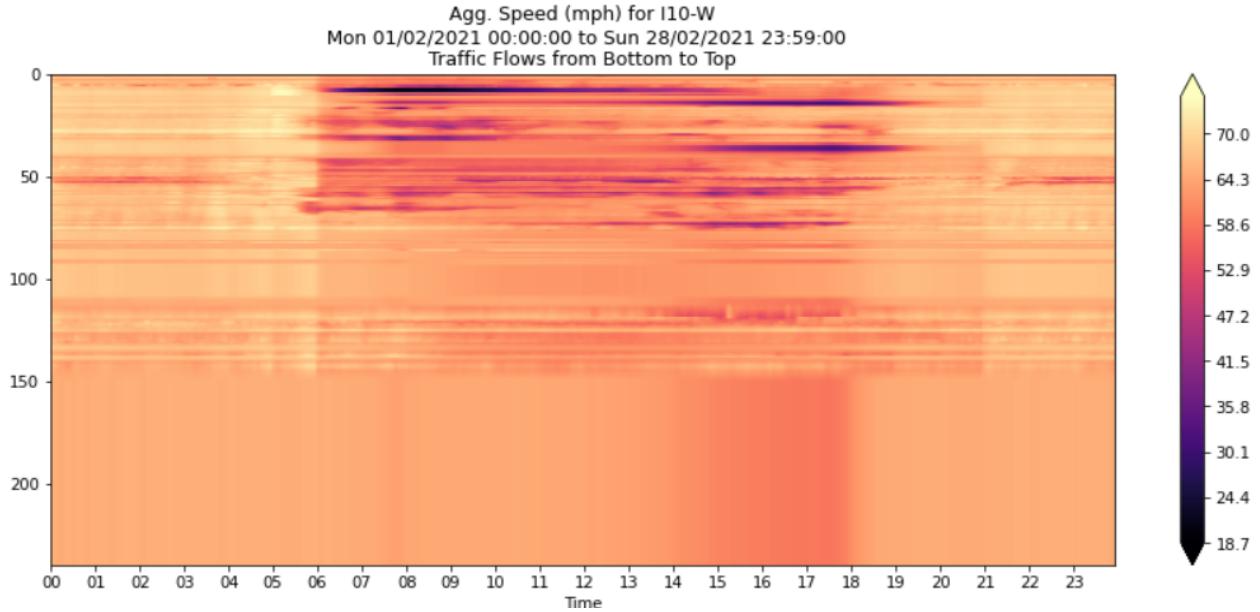


Fig 2.17: Agg Speed (mph) for the month Feb 2021

Since occupancy measures how much of the roadway is covered by vehicles, Fig 2.18 also describes the same observation we have made with the help of Fig 2.16 and Fig 2.17.

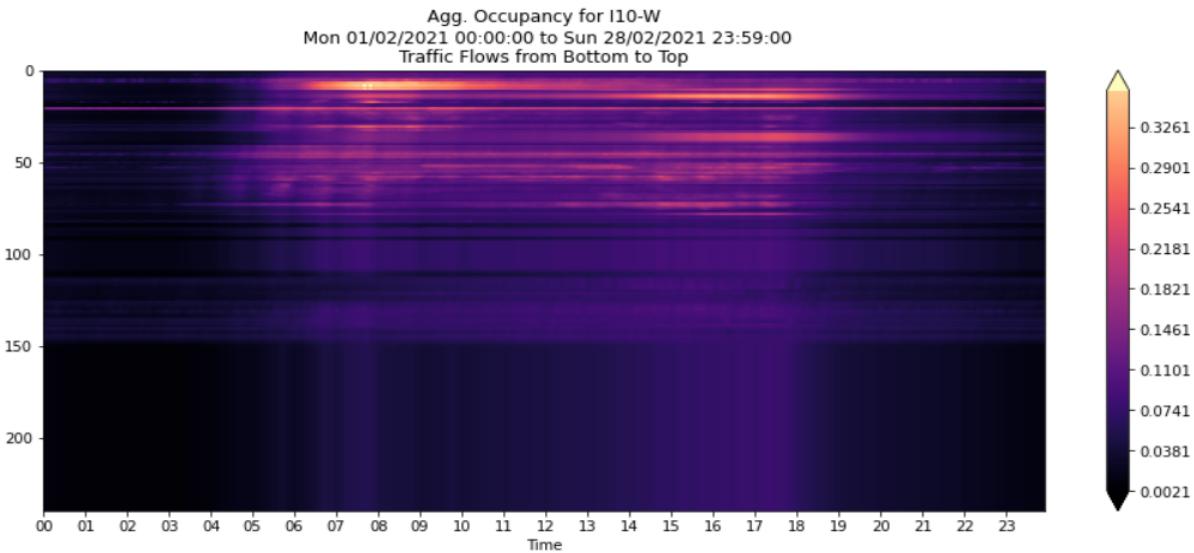


Fig 2.18: Agg. Occupancy for the month Feb 2021

With the increase in occupancy between 100 to 0 postmile and some drastic increase around 15 to 10 postmile, we can clearly infer using Fig 2.16 that the incidents around this area are responsible for this increase. Since the occupancy has increased, the number of vehicles has also increased around that time, and thus the aggregated delay has also increased.

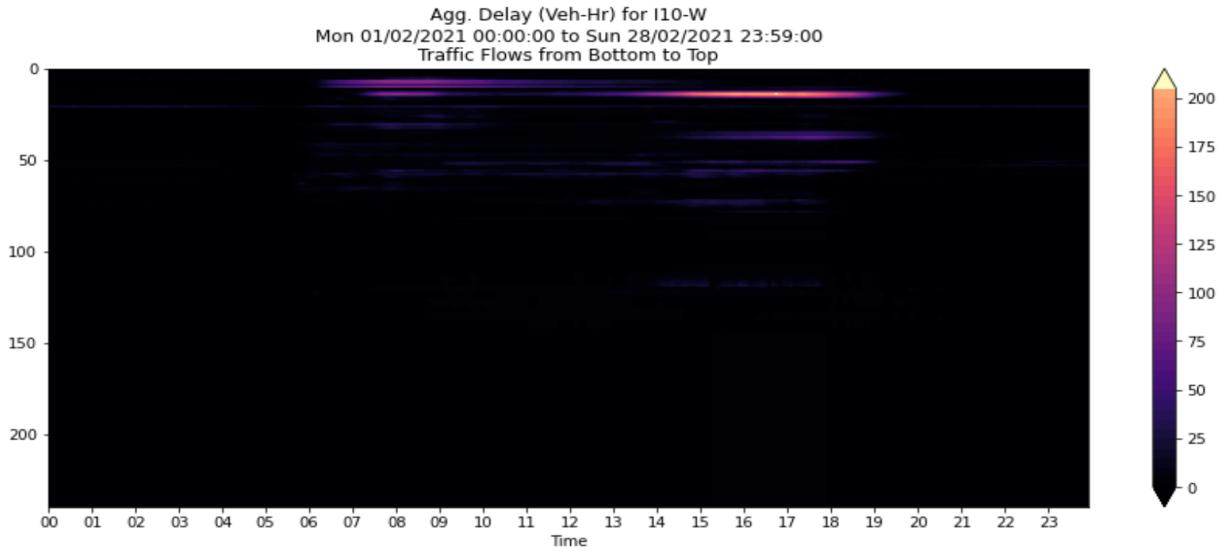


Fig 2.19: Agg. Delay(Veh-Hr) for the month Feb 2021

Also, the aggregate occupancy between 07:00 to 09:00 hours is greater than the corresponding aggregate occupancy between 16:00 to 18:00 hours. Still, the same can't be said about the aggregated delay as in Fig 2.19, as the aggregated delay is dependent upon both the aggregated occupancy and the aggregated speed. Since the aggregated speed is more significant from 07:00 to 09:00 hours, the corresponding delay from 07:00 to 09:00 is less than the aggregated delay from 16:00 to 18:00.

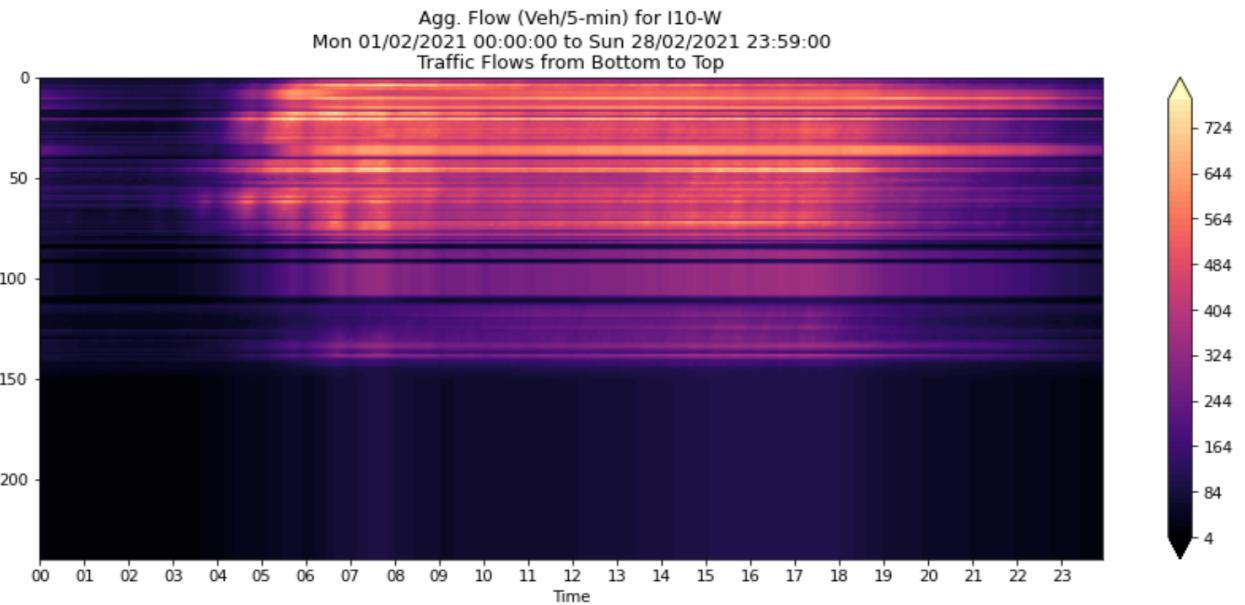


Fig 2.20: Agg. flow(Veh/5-min) for the month Feb 2021

The aggregated flow in the data is the number of cars per granularity time period, where the granularity time period taken here is 5 minutes. Therefore, Fig 2.20 explains the increase in vehicles due to increased incidents and thus an increase in occupancy.

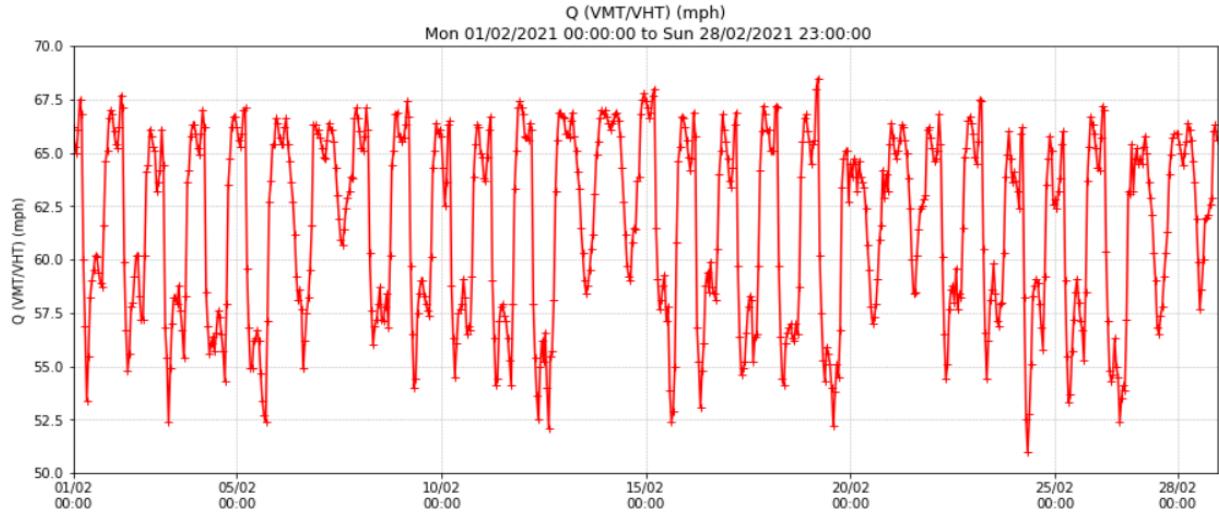


Fig: 2.21: Q(VMT/VHT) (mph) for the month Feb 2021

Similarly, Fig 2.21 shows the variation of Q, calculated by the sum of the vehicle miles traveled in a region divided by the sum of the vehicle's hours traveled in the same region in Feb 2021. Now, for a single detector, this would be the speed, and for a region, it would measure the transportation system's efficiency. Since the Q in Fig 2.21 is taken over for a month, the Q here signifies the transportation system's efficiency. Fig 2.21 thereby tells that the transportation system's efficiency varies within a specific interval. This value achieves a minimum for time intervals of 07:00 to 09:00 hours, the usual morning busy hour. It reaches a maximum of 19:00 to 06:00 hours, which is understandable as this is the time period for the least expected number of vehicles. Therefore Fig 2.21 can describe the busy periods and thus can be used in the incident analysis.

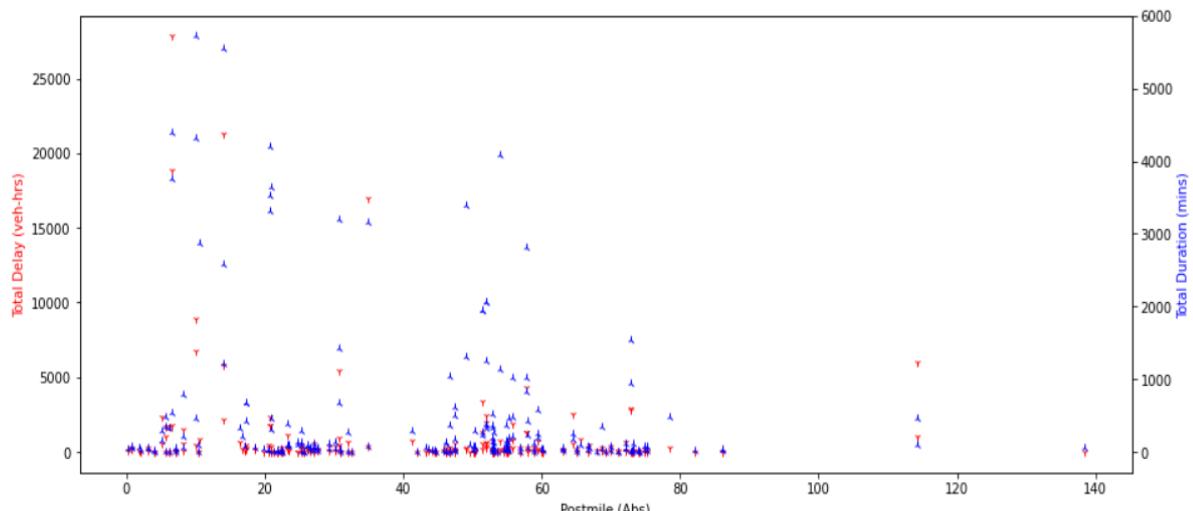


Fig 2.22: Effect of Bottleneck on total delay and total duration for month of Feb 2021

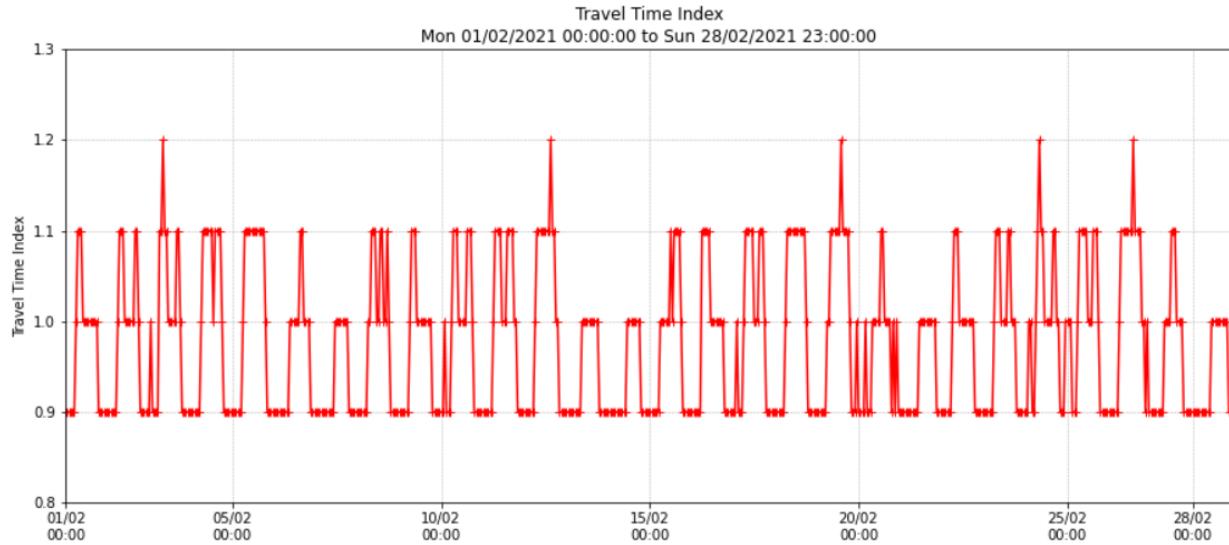


Fig 2.23: Travel Time index for the month Feb 2021

Fig 2.23 plots the variation of the travel time index in Feb 2021. The travel time index is the ratio of the average travel time for all users across a region to the free-flow travel time; hence, from the plot, the regions with the highest time travel index represent the average travel time for all users across the region has increased, and thus the peak at 3rd, 12th, 19th, 24th, 26th Feb 2021 indicates that there are some anomalies occurred on these days. These anomalies can be the incidents that occurred, which is evident from the fact that an incident on 3rd Feb 2021 resulted in a fatality and a considerable time (354 minutes) to clear it. Similarly, on 12th Feb 2021, there was a traffic hazard, and it took more than 85 minutes to remove it; similarly, there were significant incidents on the other dates. Thus the travel time index is also an important parameter that tells us about the possible incident occurrence.

3. References:

[1] Li, R., Pereira, F.C. & Ben-Akiva, M.E. Overview of traffic incident duration analysis and prediction. *Eur. Transp. Res. Rev.* 10, 22 (2018). <https://doi.org/10.1186/s12544-018-0300-1>

4. Work Distribution:

4.1 Aditya Gupta (190060):

- Studied and collected data for various parameters and factors such as flow, occupancy, delay, travel time index for the month of Feb 2021.
- Studied and collected data for microscopic params corresponding to occupancy, flow and delay..
- Plotted graphs for various variables and parameters and written scripts for scraping data.
- Reviewed and prepared results for various plots such as travel time index, Q, aggregate flow, aggregate speed, aggregate occupancy, aggregate delay and the number of incidents by postmile for the month of Feb 2021.
- Formatted the Results and prepared the final draft.

4.2 Prakhar Pradhan(190618):

- Studied and collected data for various parameters and factors such as speed, incidents, duration of incidents and type for the month of Feb 2021.
- Studied and collected data for microscopic params corresponding to speed, incidents,duration, occupancy, flow, delay and Bottleneck.
- Reviewed and prepared terms and definitions for various parameters .
- Plotted Graphs for various variables and parameters.
- Reviewed and prepared results for various plots such as travel time index, aggregate flow, aggregate speed, aggregate occupancy, aggregate delay and the number of incidents by postmile for 12th Feb 2021.
- Formatted the Results and prepared the final draft.

4.3 Chirag Sharma (190248):

- Reviewed and prepared results for various plots such as vehicle miles traveled (VMT), vehicle hours traveled (VHT), travel time index, Q, speed vs flow and speed vs occupancy for 12th Feb 2021.
- Formatted and prepared the final draft.