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SAFETY EVALUATION BY USE OF SURROGATE SAFETY PARAMETERS ON A FOUR-LANE INTERURBAN ROAD, IN INDIA

Dr. **Satbir** Singh Puwar

Director Technical, Gawar Construction Ltd.

Need of the Study



Limitations of Reactive Approach (Historical crash data)

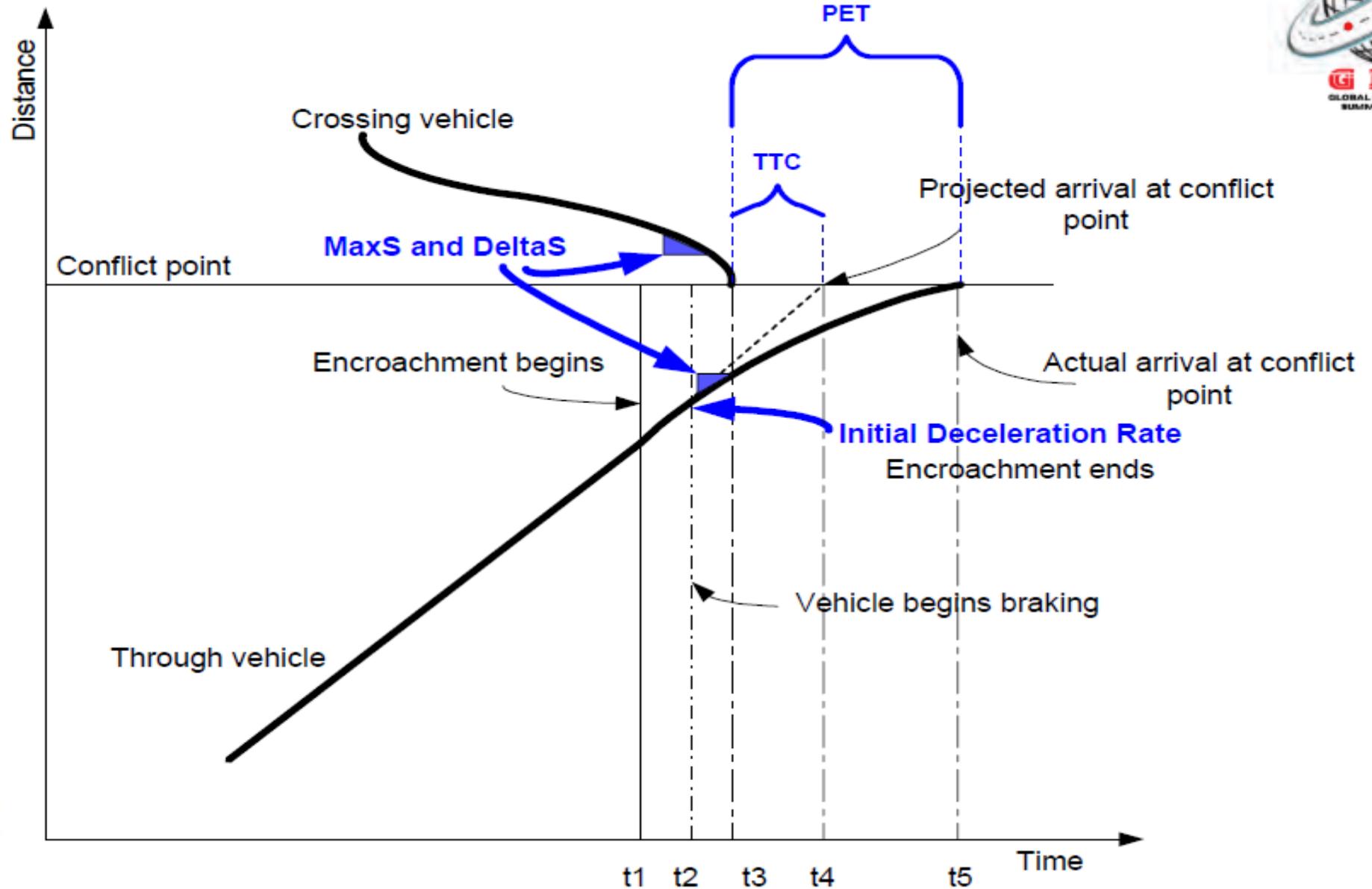
- Crashes Rare Events.
- A small sample size may lead to inconclusive results.
- Under Reporting.
- Not all crashes are reported and all reported crashes are not recorded correctly.
- Vulnerable to random variation.
- Lack of behavioural and situational aspects of events.
- A large sample size is required for analysis.

Surrogate Safety Measures?

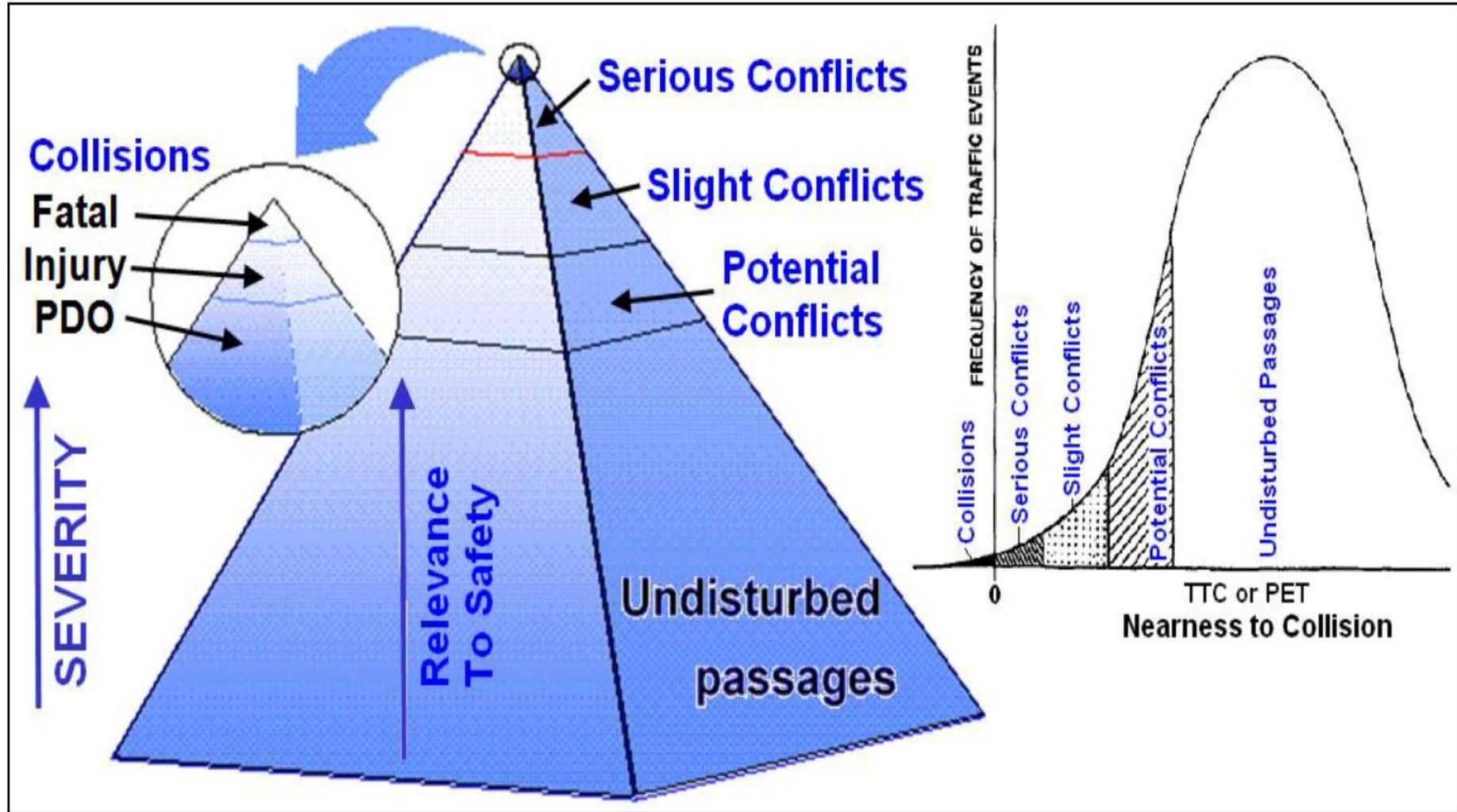


- Surrogate' means 'substitute' or 'replacement', termed Indirect safety measures
- Using surrogate measures to determine traffic safety means substituting the need for crash data with another factor representing traffic safety.
- The surrogate measures developed are based on the identification, classification, and evaluation of traffic conflicts.
- Traffic Conflict is the surrogate measure that can be substituted with historical crash data.

Surrogate Measures on Conflict Point Diagram



Pyramid of Traffic Events



Hyden's 1987 model

Study Area

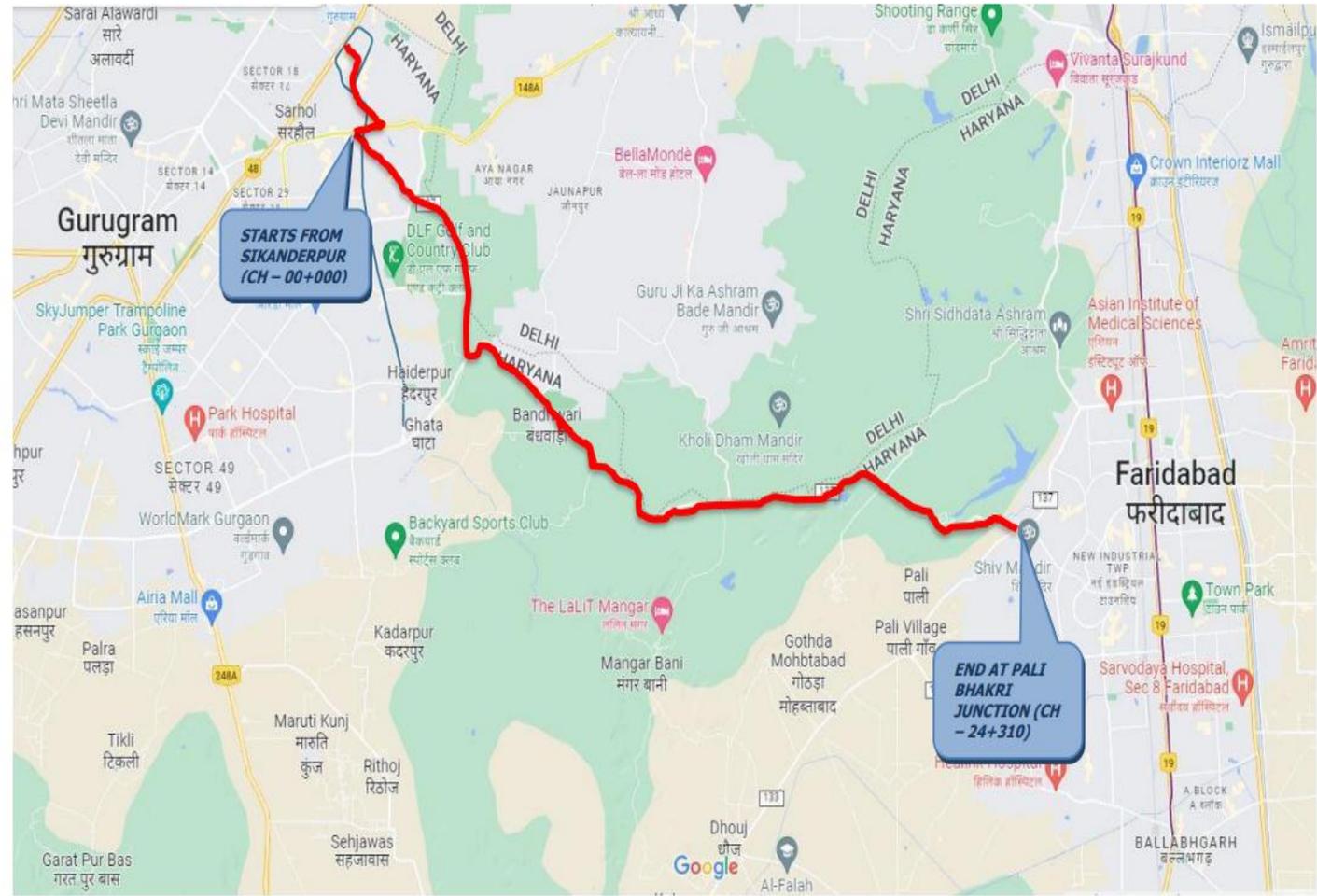


KEY MAP OF GURGAON-FARIDABAD ROAD

TOTAL LENGTH OF GF – 24.310 kms.

STARTS FROM SIKANDERPUR (CH – 00+000) AND END AT PALI BHAKRI JUNCTION (CH – 24+310)

The selected road is a typical interurban highway located in the NCR catering to traffic from Faridabad to Gurgaon and vice versa. It is a toll road, having a 4-lane configuration.



Microsimulation



- Microsimulation is a computerized analytical tool that perform highly detailed analyses of activities such as highway traffic flowing through an intersection/road facility.
- The software used to model the network in this study is VISSIM 7.0.
- VISSIM is a microscopic multi-modal traffic flow simulation software.
- The VISSIM simulation model has been validated against data from various real-world situations.

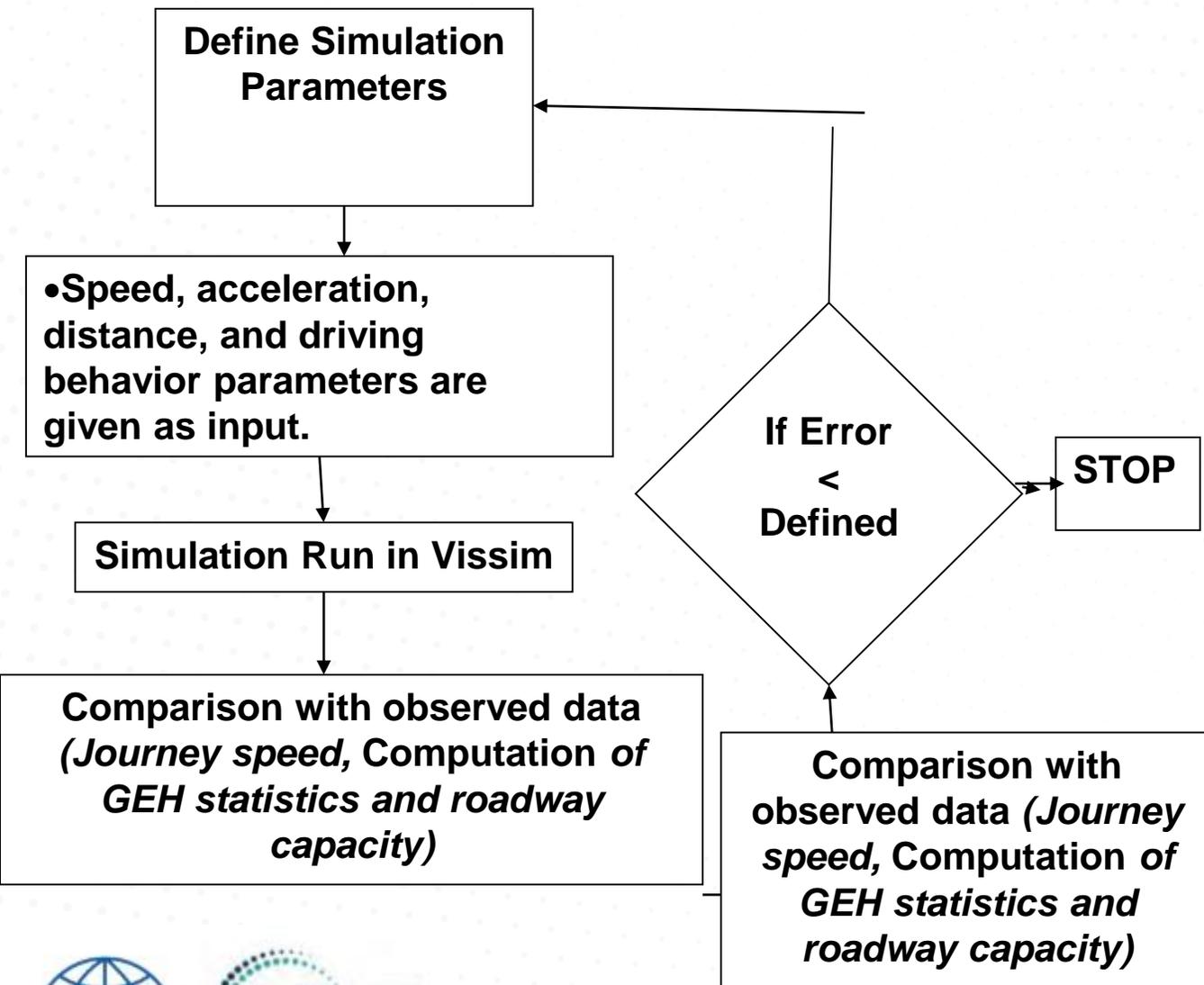
Setting Network in VISSIM & Data Input



- The entire stretch from Gurgaon to Faridabad road is represented in VISSIM.
- Initially in VISSIM road configuration has been set up as a background image from the as-built drawings.
- Vehicle input is entered as recorded from the site as the primary source data.
- Vehicle routes are given from Gurgaon to Faridabad and Vice Versa.
- Simulation is run with default inbuilt parameters.
- Calibration of the VISSIM carried out by changing input parameters



Calibration and Validation



- GEH formula was developed Geoffrey by E. Havers, in London, in the 1970s. It is like a chi-squared test and an empirical formula that has proven useful for a variety of traffic analysis purposes.
- For hourly traffic flows, the GEH formula is:

$$GEH = \sqrt{\frac{2(m - c)^2}{m + c}}$$

Where:

'm' is the value from the traffic model (per hour)

'c' is the real-world traffic value (per hour)

Surrogate Safety Assessment Model



- It is a software application that reads trajectory files generated by microscopic simulation programs and calculates SSMs of safety.
- This approach eliminates the subjectivity associated with the conventional TCT and allows assessment of the safety before a road crash occurs.
- The surrogate safety parameters such as TTC, PET, DR, Max S, and Delta V are computed for each of the locations



Analysis of Road Safety on Intersections

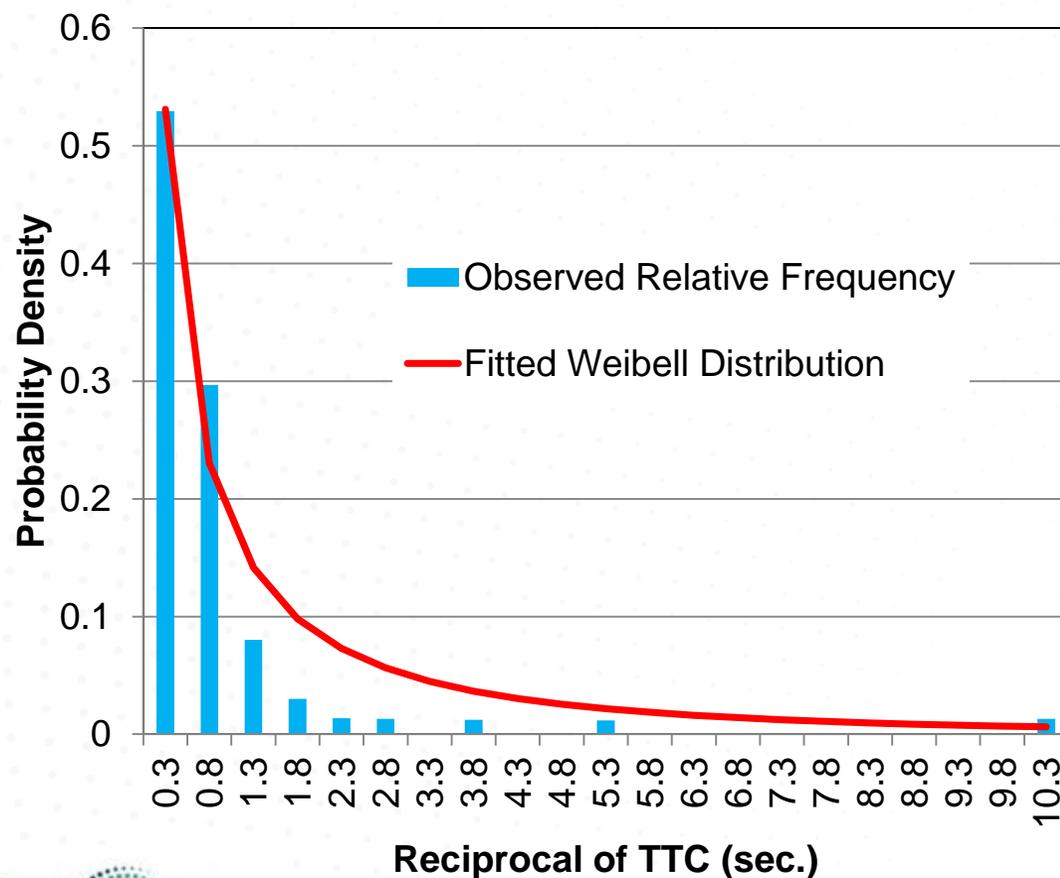


- Vehicle trajectory data is built for each of the intersections by simulation through VISSIM.
- For an operating speed of **80 kmph**, the **SSD is 120 m**, for which the time headway of **5.4 seconds** or **5 seconds**. Therefore, a maximum TTC threshold of 5 seconds is adopted for TTC.
- The range of the maximum PET threshold is limited by SSAM with a maximum allowed value of **9.95 seconds**.
- Calibrated & validated vehicle trajectory files imported to SSAM to arrive at the SSMs, such as TTC, PET, DR, Max S, and Delta V are computed for each of the locations separately



Analysis of Road Safety on Intersections by TTC

Distribution of Total Time to Collision (TTC), Junction

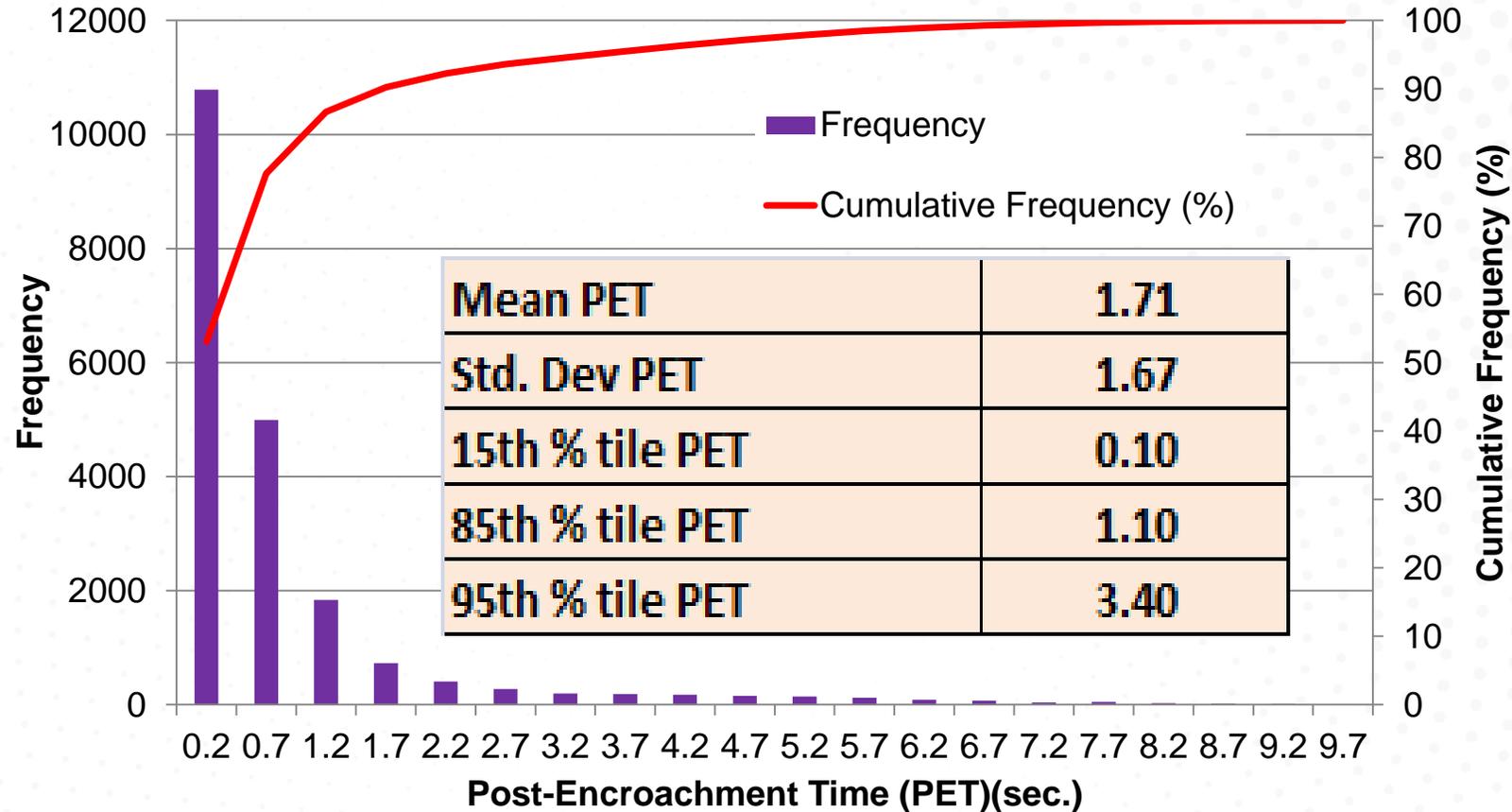


Limit	Frequency	Observed Relative Frequency	Fitted Weibull Distribution	Cumulative dist. Function CDF(1)	Cumulative dist. function CDF(2)	D-static tic
0.3	25446	0.53	0.53	0.53	0.42	0.11
0.8	14263	0.29	0.23	0.83	0.59	0.24
1.3	3852	0.08	0.14	0.91	0.68	0.23
1.8	1446	0.03	0.09	0.94	0.74	0.19
2.3	657	0.01	0.07	0.95	0.78	0.17
2.8	624	0.013	0.06	0.96	0.81	0.15
3.3	0	0	0.05	0.96	0.84	0.12
3.8	584	0.01	0.04	0.98	0.86	0.11
4.3	0	0	0.03	0.98	0.88	0.09
4.8	0	0	0.03	0.98	0.89	0.09
5.3	566	0.01	0.02	0.99	0.90	0.09
5.8	0	0	0.02	0.99	0.91	0.08
6.3	0	0	0.02	0.99	0.92	0.07
6.8	0	0	0.02	0.99	0.93	0.06
7.3	0	0	0.01	0.99	0.93	0.05
7.8	0	0	0.01	0.99	0.94	0.05
8.3	0	0	0.01	0.99	0.94	0.04
8.8	0	0	0.01	0.99	0.95	0.04
9.3	0	0	0.01	0.99	0.95	0.03
9.8	0	0	0.01	0.99	0.96	0.03
10.3	630	0.01	0.01	1.00	0.96	0.04

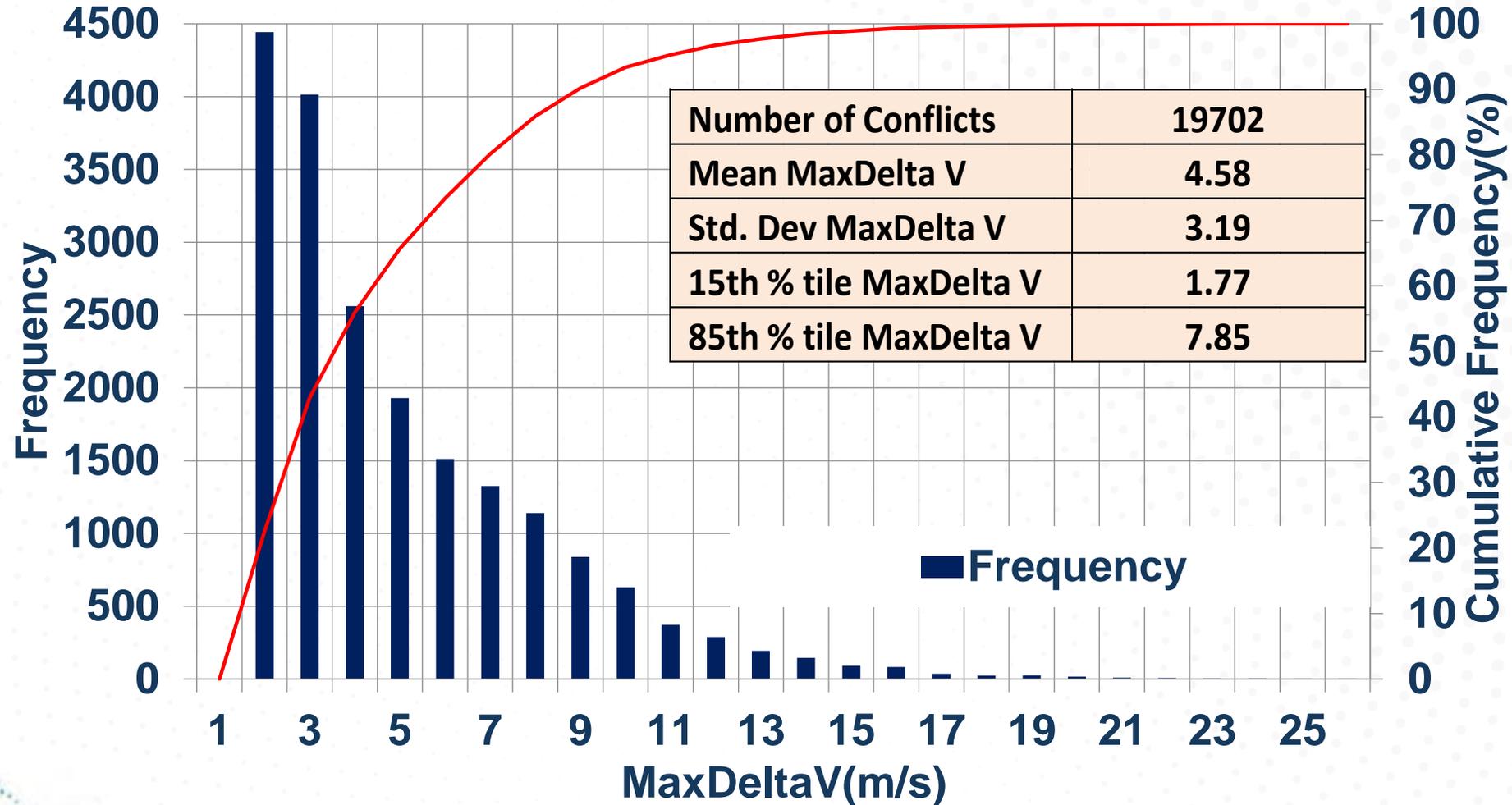
Analysis of Road Safety on Intersections by PET



PET Distribution for Un-Controlled Intersection



Analysis of Road Safety on Intersections by Max Δ



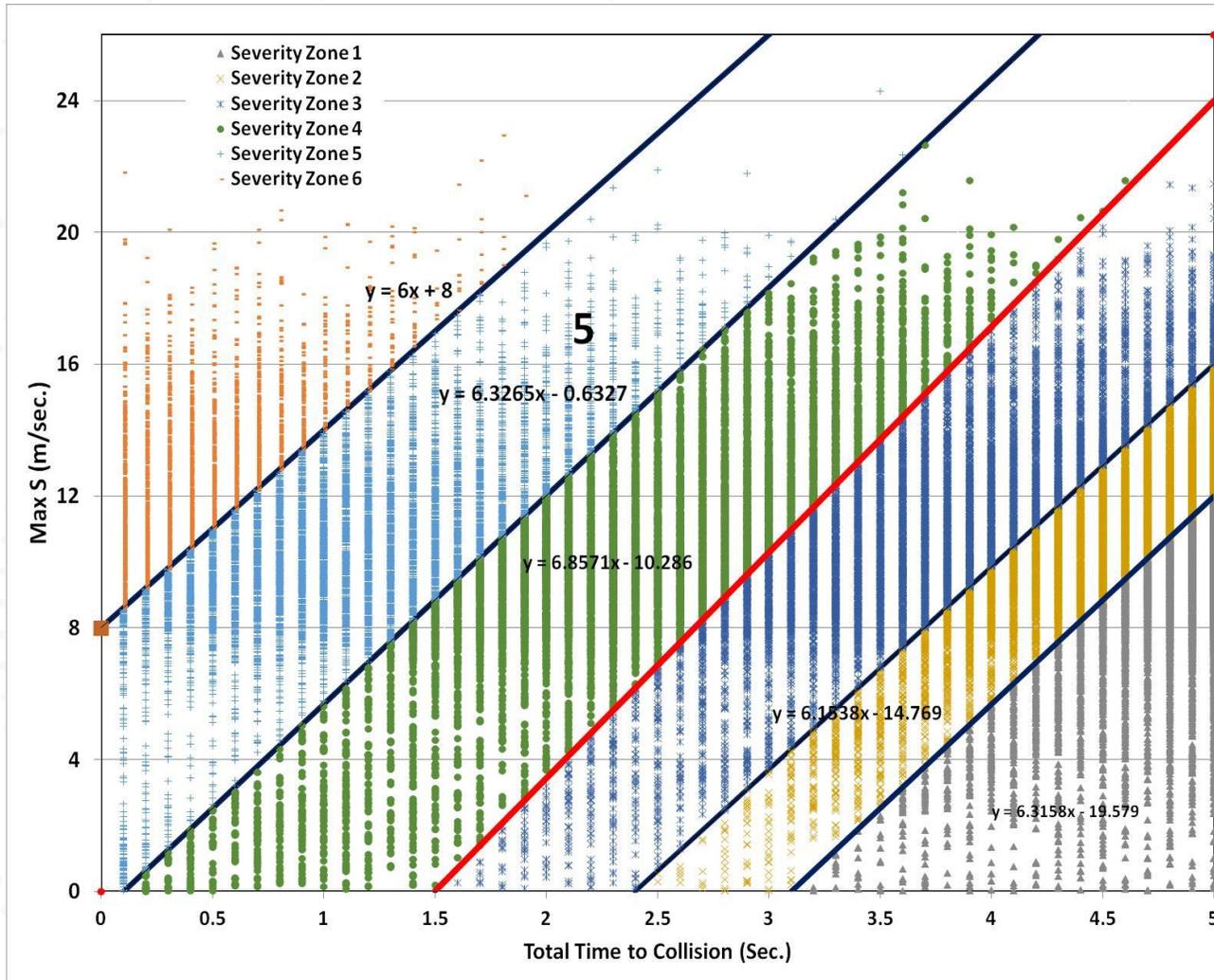
: Max Δ V frequency distribution plot for Intersections



Analysis of Severity Score by Max S v/s TTC & Severity Zones based on TTC on Intersections



MaxS Versus TTC Conflict Severity Zones Plot



Number of Severity Zones and percentage of samples in each zone

Severity Zone	Criteria (TTC)	Criteria Max S	Percentage (%) of Samples
1	3.1	12	19.34
2	2.4	16	19.20
3	1.5	24	19.31
4	0.1	31	18.50
5	0	38	18.26
6	0	>38	5.38

Assigned Severity score based on TTC & Max Delta V Intersections



TTC Values ROC Scores	TTC Range (Seconds)	Sample size (%)	Collision Propensity Level
1	TTC > 4.3	33.68	Low
2	2.90 < TTC ≤ 4.3	25.48	Moderate
3	1.50 < TTC ≤ 2.90	18.96	High
4	TTC ≤ 1.50	21.88	Extreme

Max Delta V ROC Score	Max ΔV Range (m/sec)	Percentage of Conflicts	Sample size (%)	Collision Propensity Level
1	Max ΔV < = 4.13	62.07	9764 (62.07)	Low
2	4.13 < Max ΔV ≤ 9.0	31.41	4941 (31.41)	Moderate
3	9.0 < Max ΔV ≤ 15	6.24	982 (6.24)	High
4	Max ΔV > 15	0.28	44 (0.28)	Extreme

Assigned ROC Scores based on TTC scores

Assigned ROC based on Max ΔV for Intersections

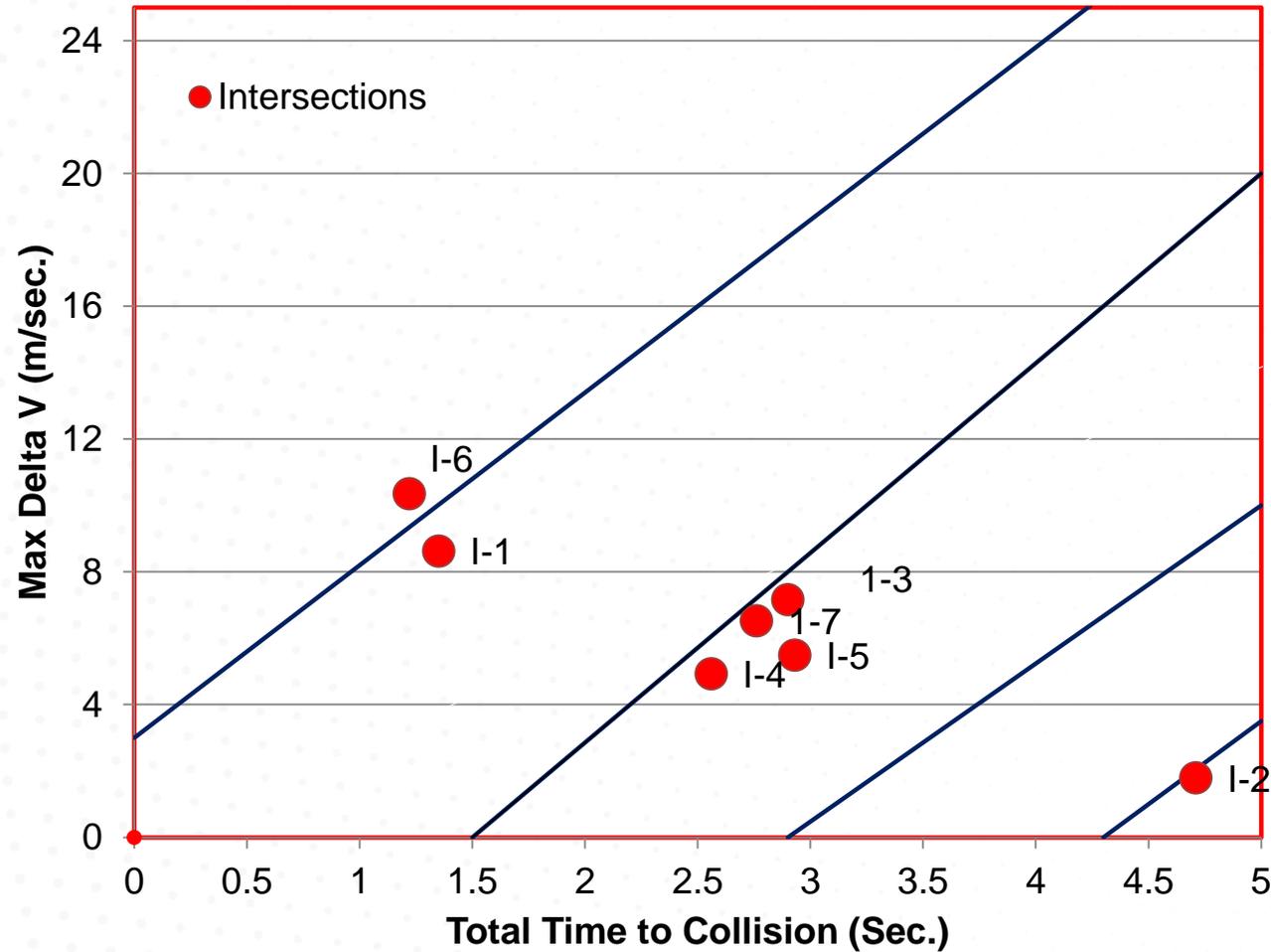
Results

- The critical TTC on interurban signalized and un-signalized intersections catering to heterogeneous traffic conditions is **1.5 seconds** and **1.30 seconds** respectively.
- The critical deceleration rate is observed as **0.486 m/s²** which implies that any conflict with more than this value will lead to a fatal crash under the scenario of heterogeneous traffic conditions.
- The max ΔV values deduced for the study corridor on interurban intersections catering to heterogeneous traffic movement is **4.58 m/s**.
- The threshold value of PET for un-signalized intersections is found to be **1.71 seconds**.

Crash Potential V/S Crash History on Intersections

Estimated level of safety on intersections conforming to the developed Crash Severity Zone of the Study Corridor

Number and Severity of Road Crashes from 2021 to 2025 on the Intersections



S. No.	Section ID.	Number of Fatal Crashes	Number of Grievous Crashes	Number of Minor Crashes	Number of Non-injury Crashes
1	I-1	2	4	2	0
2	I-2	0	0	0	0
3	I-3	1	2	4	2
4	I-4	0	4	6	4
5	I-5	0	5	7	18
6	I-6	1	7	4	5
7	I-7	0	9	14	23

Conclusión

- All types of road crashes occurred during the 5 years in all the intersections. Intersection, I-6 accounted for one fatal crash accompanied by 7 grievous injuries, and intersection I-1 had two fatal crashes accompanied by 4 grievous injuries these two intersections I-1 and I-6 fall under Zone 5 and Zone 4. These two intersections denote the true representations of the ground realities and hence fall under Zone 4 and 5.
- Further, intersections namely, I-3, I-4, I-5, and I-7 fall under Zone 3 as this zone represents serious injury and truly represents the ground conditions in case of I-3, I-4 and I-7, which is aptly reflected in the graph, as intersections fall near the periphery of Zone 4 under Zone 3. But on I-5 there is no crash which is wrongly placed in Zone 3.
- Lastly, matching the reported trend in road crashes, I-2 falls under Zone 1 as it no crash.



Thank You

Dr. Satbir Singh Puwar

Director Technical, Gawar Construction Ltd.

sspuwar@yahoo.com