

Accident Narrative

At about 15:00 on Sunday, 1 September 2013, there was a report of crash between a van and a semi-trailer truck. The crash occurred on two lane road, Highway No.359 (Sa Kaew-Kao Hin Son) in front of NGV station, around 59+000 km. A van sustained heavy damage on its frontal part resulting 2 occupants dead including van driver; however, truck had only minor damage on its left part. According to the information, a van was in full capacity with foreign passengers and was heading westward on a trip to Bangkok from Aranyaprathet (Figure 1), whereas the truck was heading east to the border market. According to the truck driver, there was a vehicle suddenly trying to enter to NGV station which forced him to take an evasive maneuver to another lane. However, he was unaware of the van coming in opposite direction and got collided with it. The schematic of the accident scenes are shown in Figure 2.

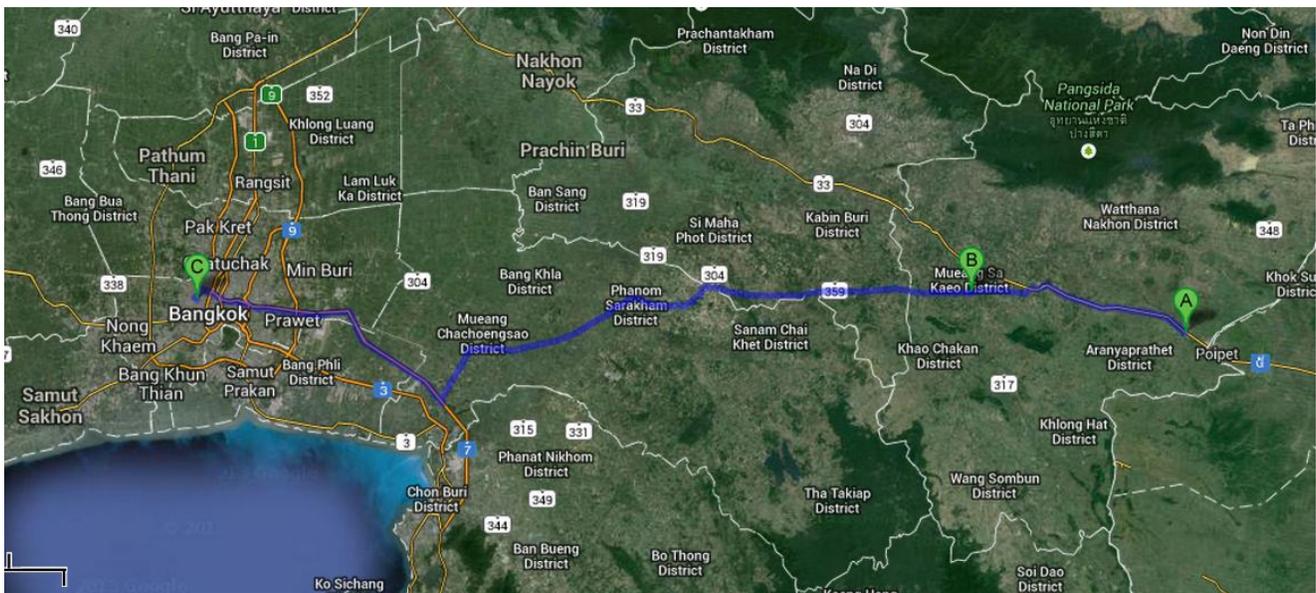
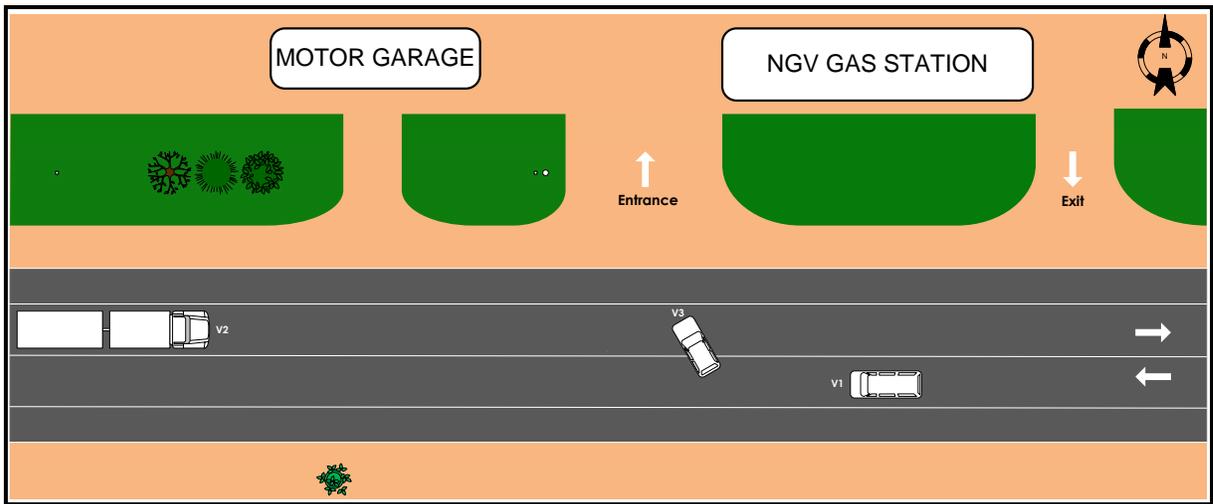
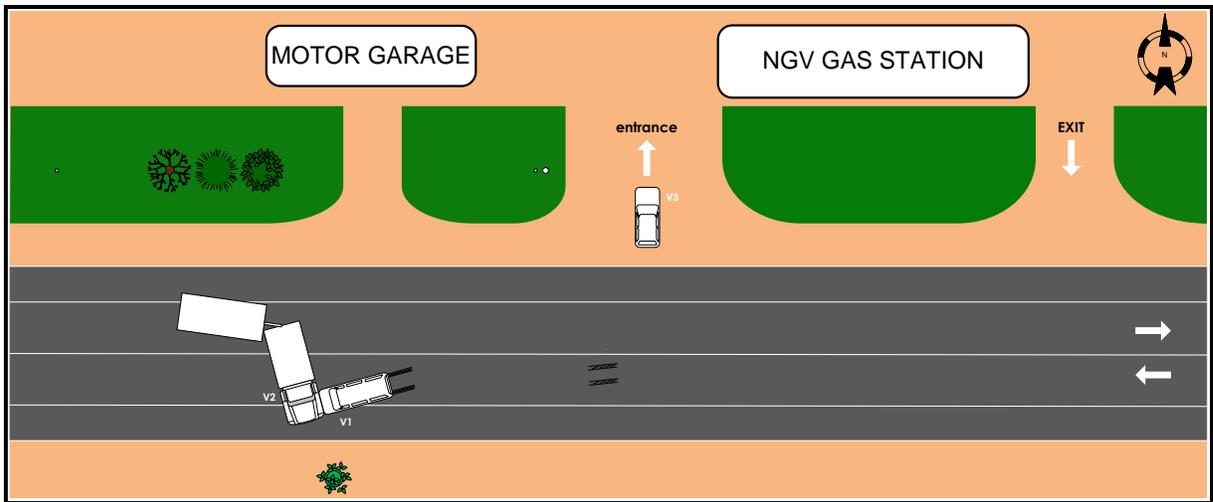


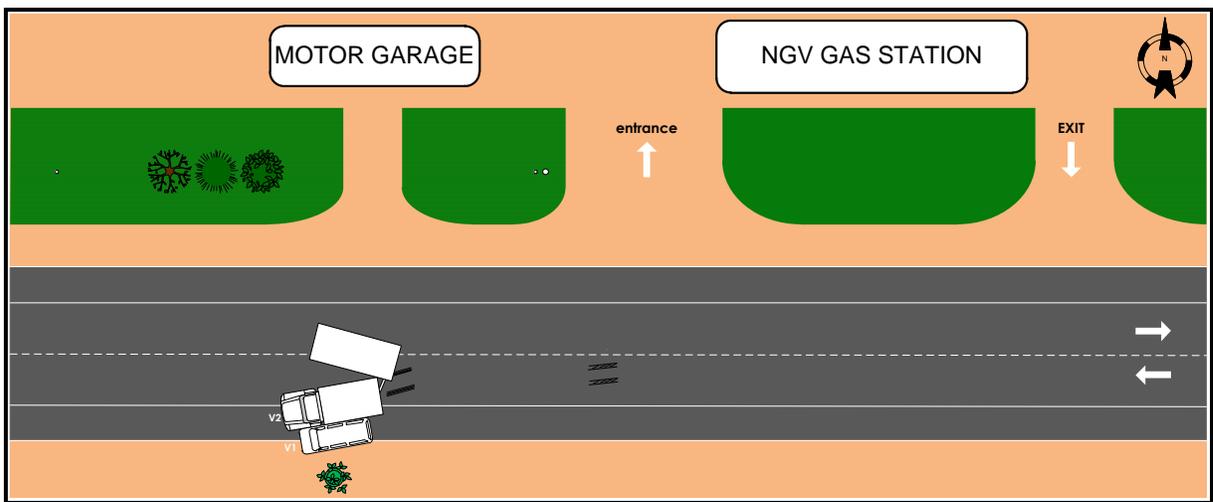
Figure 1 Location of Crash site, (A) is the origin of the van, (B) is the crash site and (C) is the destination of the van



(a)



(b)



(c)

Figure 2 Schematic of Accident Scene, (a) before Collision, (b) during Collision (POI) and (c) after Collision (POR)

Vehicle Information

Truck (V1)

V1, the 22 wheeled semi-trailer trucks was a HINO500 FM2P, 6 cylindered diesel engine with 10,520 cc. The truck belongs to BigDon transport co. The truck part has a license plate number 82-6325 Chacheongsao but the trailer part has no license plate attached. The dimension of the truck is shown in the table 1.

Table 1 Dimension of Truck

Truck	
Length (mm)	8,600 mm
Width (mm)	2,300 mm
Height (mm)	2,840 mm
Wheel Base (mm)	4,650 mm)
Gross Weight (kg)	25,000 kg
Trailer	
Length (mm)	7,500 mm
Width (mm)	2,500 mm
Wheel Base (mm)	3,950 mm

Table 2 shows the information of the tires of the truck.

Table 2 Details of the Tires of V1

	Location	Damage	Manufacture	Tire Name	Year	Size	Load Index& Speed Symbol	Tread Depth(mm)
Truck	1R	NO	Bridgestone	R157	3912	11R22.5	Single:3,000kg Dual:2,725kg	5.4
	1L							7.3
	2R							5.7
	2L				7.7			
	3R				5.3			
	3L				6.2			
Trailer	1R	NO	Bridgestone	L-Miler	N/A	11R22.5	Single:3,000kg Dual:2,650kg	3.2
	1L							7.3
	2R							10.8
	2L							1.0
	3R							7.0
	3L							10.7

Damages of V1

Truck had some damages on left side of its front part. The damages include minor deformation of left door, driver compartment and front left tire and its axle. The most obvious damage is the deformation of the fuel tank in the left. However, TARC observed that the truck has been driven from police station to the garage after the investigation, which clearly shows that there was no any fuel leakage in the tank. Similarly, the bed of the truck and trailer was empty and remained unharmed by the crash.



Figure 3 Damages of the Truck

Van (V2)

V2, the van, was a Toyota Commuter, 16 values with 2,494 cc, diesel engine, 16 seats, 4 wheeled with white in color. Specification of the van is shown below in table 3. The van belongs to 'MP Friendly Service' with the license plate number of 30-0210 Trat. Original seating spec of the van consists of 5 seats row. However, the back seat row had been folded down for luggage space during the trip. Therefore, there were only 12 seats available in total, including driver seat. Also, original tire spec of van is 195R15C model but tires used in this van were modified as described in table 4.

Table 3 Dimension of Truck

Length (mm)	5,380 mm
Width (mm)	1,880 mm
Height (mm)	2,285 mm
Wheel Base (mm)	3,110 mm
Gross Weight (kg)	2,110 kg

Table 4 Details of the Tires of V1

Location	Damage	Manufacture	Tire Name	Year	Size	Load Index & Speed Symbol	Tread Depth(mm)	Pressure (Psi)
1R	Yes	Bridgestone	Duravis	2513	215/70R15	-	7.6	-
1L	No						2.5	48
2R							7.5	55
2L							3.3	55



Figure 4 Original Structure of the Van

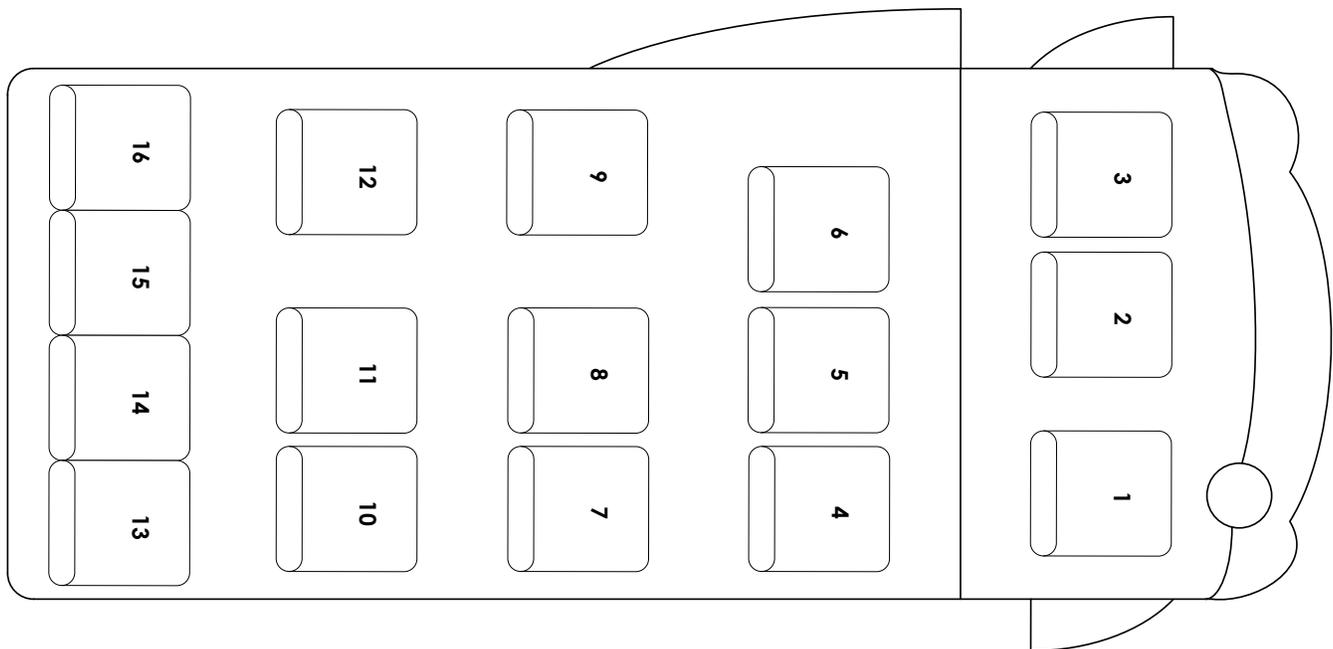


Figure 5 Capacity of the van

Figure 5 shows the capacity of the van to carry the passenger in one trip. It is to be noted that, seat no. 2, 13, 14, 15 and 16 were folded, while the rest of the seat was occupied by the passenger at the time of accident. All the seats were equipped with seat belts and two fire extinguishers were also found inside the wrecked van during investigation.

Damages of V2

The van sustained a massive damage both on its in exterior and interior part. As shown in figure 6, the frontal part of the van was damaged heavily, with the highest deformation at the central front part. The front bumper, hood and the supporting pillars were bent from its original position. Also, there was damage to its front left wheel, with the tire flat. According to one of the survivor from the accident, sliding door on the left side of the passenger compartment was crushed by the impact and as a result, the door stops functioning and the survivors used rear door to escape sooner after the crash. Similarly, no damages were observed at the back part of the van as seen from Figure 6.



Figure 6 Damages of the van

Severe interior intrusion was also observed during the vehicle inspection as shown in Figure 7 (b). The interior frontal part of the van was intruded especially at the driver's compartment and the frontal head roof and windshield was also deformed downwards. The distance between driver's seat to the radio player was found to be too small comparatively from the original structure (Figure 7). And the console was also found to be destroyed by the intrusion of the engine and other frontal components.



(a)

(b)

Figure 7(a) Original interior structure, (b) Damages on the interior structure of the van after crash

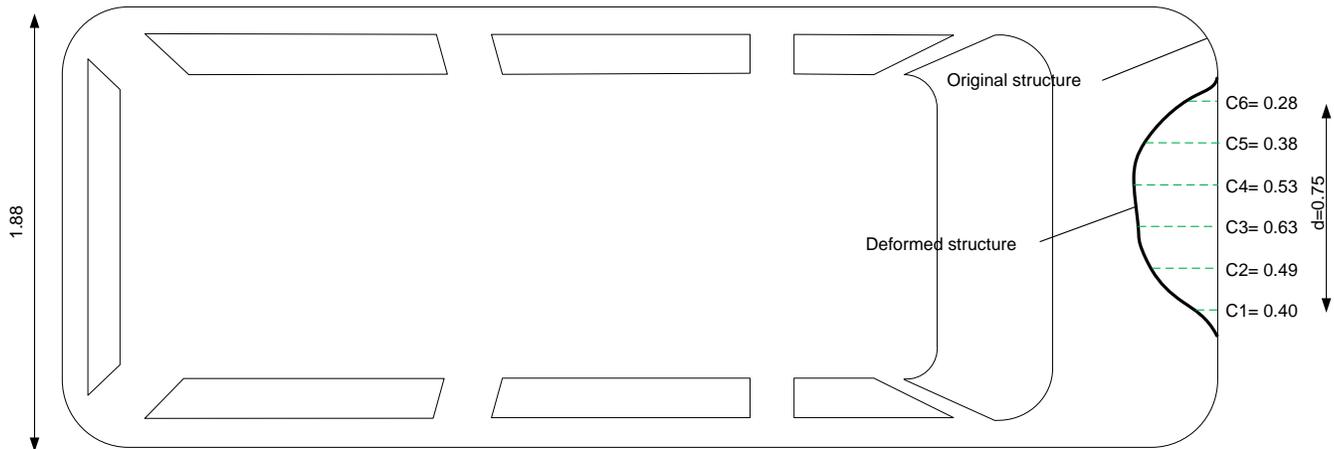


Figure 8 Crush Deformation of the van

TARC performed the crash speed analysis to determine the van speed during the impact and before braking by using the crush deformation as shown in Figure 8. Following steps are carried out:

Impact Angle, $\theta = 3.00^\circ$
 Gross vehicle weight = 2,110 kg
 Gross passenger weight = 715 kg
 Actual weight, $w = 2,825$ kg

Stiffness Coefficient of Toyota Van (Frontal Impact)

$A = 627.81$ N/cm (358.75 lb/in)
 $B = 106.62$ N/cm² (154.75 lb/in²)

$$G = \frac{A^2}{2B} = 1,848.33 \text{ N}$$

$$E = \left(\frac{w}{5}\right) \left\{ 5G + \frac{A}{2} (C_1 + 2C_2 + 2C_3 + 2C_4 + 2C_5 + C_6) + \left(\frac{B}{6}\right) (C_1^2 + 2C_2^2 + 2C_3^2 + 2C_4^2 + 2C_5^2 + C_6^2 + C_1C_2 + C_2C_3 + C_3C_4 + C_4C_5 + C_5C_6) + \tan^2\theta \right\}$$

$$E = 11,725,045.33 \text{ N-cm}$$

$$E_{\text{actual}} = E(1 + \tan^2\theta) \\ = 12,109,017.29 \text{ N-cm} \quad (121,090.17 \text{ N-m})$$

$$V_{\text{impact}} = \sqrt{\frac{2gE_{\text{actual}}}{w}} \\ = 28.98 \text{ m/s} = \mathbf{104.35 \text{ km/h}}$$

$$V_{\text{prebrake}} = \sqrt{v^2 - 2fgd} \quad \text{where,} \quad f = -0.4; \quad d = 16.6 \text{ m} \\ V_{\text{prebrake}} = 31.15 \text{ m/s} = \mathbf{112.14 \text{ km/h}}$$

Highway Information

The crash occurred on the Highway No.359, coordinate 13.770925N, 102.067454E, in Sakaeo Province. It is a 2 lane highway connecting Highway No.304 at Phanonsarakham District of Chachoengsao Province to Highway No.33 (Suwannasorn Road) at Sakaeo City. Highway No.359 is an optional route chosen by the driver when they have to make a trip from Cambodian border to Bangkok because it is a shortest path comparing to other main route such as highway No.33. Because of the high volume traffic along this road, it is under expansion up to four lanes.

The accident occurred in flat section at around km 59+000. However, downhill slope can be observed at the west with the crest of the hill located just around 300 meters west from the crash scene. The width of the lane is 3.60 meters and the roadway surface pavement is asphalt concrete. TARC also took an exposure data (speed) after the crash on the next day, at the same time period. It is found that an average speed during one hour on the eastbound approach for truck was 68.6 km/h and 82.16 km/h for all vehicle. For westbound approach, average speed of van was 74.5 km/h and overall average speed is 69.63 km/h.

Physical Evidence

TARC investigated the accident site and found the 16.6 m. long skid marks of both right and left wheels in the travel lane. Also, some tire marks were also found to be continuing on the shoulder and stopped at the point of rest as shown in Figure 9. Skid mark of truck couldn't be found during an investigation. Similarly, several access points on the eastbound approach nearby the accident scene were seen. These are the entrances and exit for the garage and gas station where several conflicts were observed between the through traffic and the turning vehicle towards the gas station.



Figure 9 Skid and Tires mark at crash scene

Driver Information

According to the police, truck driver stated that he was on his trip from Kao Hin Son, Chachoengsao Province to pick up the goods from the border side. He further stated that before the crash, there was a car driving westward (opposite side of truck) and suddenly turn right into the gas station. He tried to stop the truck by applying brake; however, as he drove downhill-combined with a drag force from its trailer part, suddenly braking resulted the truck lost its control truck. He said that once the truck part lost its the control, its trailer part pushed the truck part further until truck part rotated back, stayed across the approach of the van and led to the crash.

Similarly, the van driver was 50 years old male. According to van company, he usually used to drive along the route of Bangkok-Trat. He seldom drove on Highway No.359 and might be not familier with the road condition and environment along the crash site. The van was hired by tourist agency in order to transport tourists from Cambodian Border to Kao San Road in Bangkok. According to the police, before the crash, there was a car ahead of the van trying to turn right into the gas station which force the van to keep left before colliding with the truck. Also, according to the survivors, it had been just 30 minutes the van started its journey from Aranyaprathet.

Injury Information

There were 11 casualties in the van including the van driver. Two of them including the van driver and the passenger who sat in the middle of the second row (behind driver's row) were dead due to the impact. Likewise, another passenger who sat in the front row (left to driver) and two persons on the second row were severely injured. Two passenger on the left back seat received modest injury while other passengers who stayed in the right back seat had only minor injury and were able to escape from the van by themselves. There was no damage to truck driver.

Figure 10 shows the casualties according to the seating position and level of injury in the van. Since this is a head on collision to the van, most of the occupant seating in the front in has more serious injury than others. Also, Table 5 shows the summary of the occupant's injury based on the ICD 10 code.

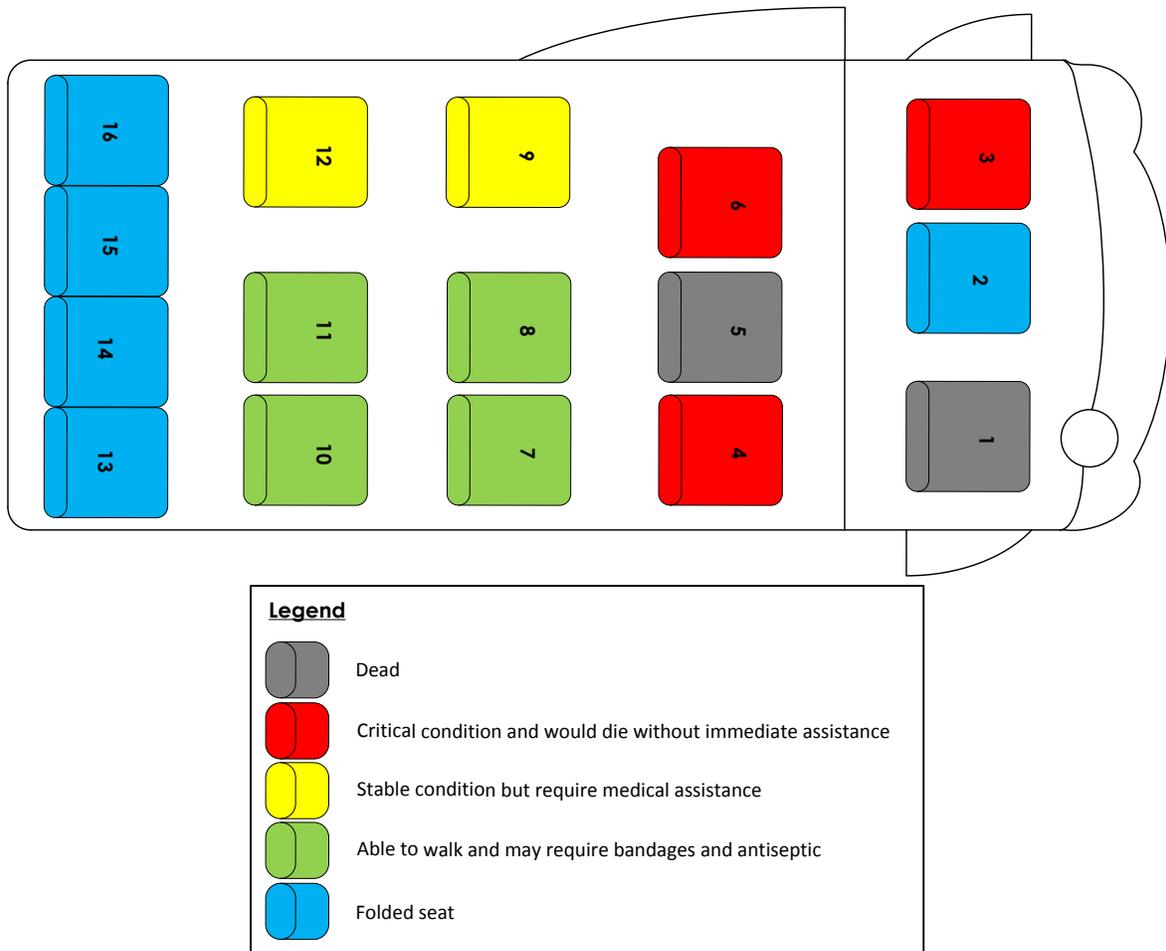


Figure 10 Seating position and the Injury Level

Table 5 Summary of Occupant's injury based on ICD 10 codes

	Position	Diagnosis	ICD-10	Description
Injured	3	Fracture of pelvic	S32.8	Fracture of other and unspecified parts of lumbar spine and pelvis
	6	Brain concussion	S06.0	Concussion
	4	Subarachnoid hemorrhage	S06.6	Traumatic subarachnoid hemorrhage
		Fracture of C2	S12.1	Fracture of second cervical vertebra
	9	Laceration of small intestine	S36.439	Laceration of unspecified part of small intestine
	8	Muscle strain	T14.6	Injury of muscles and tendons of unspecified body region
	7	Laceration wound at left leg	T13.1	Open wound of lower limb, level unspecified
	12	Blunt abdomen	S39.9	Unspecified injury of abdomen, lower back and pelvis
	10	Left shoulder dislocation	S43.0	Subluxation and dislocation of shoulder joint
11	Bleeding per nostril	S00.3	Superficial injury of nose	
Dead	1	Traumatic brain injury	S06.9	Unspecified intracranial injury
		Fracture of C-Spine	S12.9	Fracture of neck, part unspecified
	5	Traumatic brain injury	S06.9	Unspecified intracranial injury
		Skull and Maxillofacial fracture	S02.9	Fracture of skull and facial bones, part unspecified

Accident Contributing Factors

Human Factor

The driver should be aware to drive in lower speed in the two lane undivided highway with several access points, especially during over taking and making a turn at access point. In this accident, the truck driver who drove with higher speed on downhill section tried to avoid the crossing car, losing the control and colliding with the van coming from opposite direction. Also, it was a wrong decision made by the car driver to make a sudden right turn towards the gas station, being unvigilant of the truck coming.

Roadway and Environment



Figure 11 Roadway condition at crash scene



Figure 12 Vehicle Conflicts at the access point

During the investigation at the crash site in the same time of the next day, TARC observed three access points near the crash scene, one access to the motor garage and two accesses to the gas station for entrance and exit purposes (Figure 11). During this time, it was seen that many vehicles were going to the gas station, thereby disturbing the through traffic mostly (figure 12). These types of conflict at the access points may misguide some vehicles and result unexpected crash, especially when a high speed vehicle approaching such access points. Also, we can see from the figure that the marking on the road esp. median is not clear which encourages illegal overtaking and maneuver (Figure 13). Hence, combined effect of these kinds of problems in the roadway is the major contributing factor for the accident.



Figure 13 illegal overtaking and sudden maneuvering at the access point

Injury Contributing Factors

Human factors

The entire seat in the van was equipped with seat belt. Use of seat belt mitigates the impacts to a motorist during crash, thereby reducing the severity of injuries. Seat belt also prevent the occupant from being ejected during a crash. However, some of the occupant did not used seat belt during the crash, increasing the chance of getting injured by the sudden impacts. According to the information, two passengers sitting in the second row did not use the seat belt while the rest of the passenger was restrained with seat belt. According to the survivor, one of the passengers not using the seat ejected from his seat and struck with the intruded interior frontal part of the car and died at scene. It means, not using the seat belt contributed for the reason of his death. Similarly, another passenger not using seat belt was severely injured.

Seat retention factors

Three point seat belt was equipped in the front row seats and lab seat belt was equipped in rest of the seats. One of the factors to the injuries is the lap seat belt. Two passengers sitting in the left back stated that they used seat belt during the accident. However, the seat belt was two pointed and as a result, they had decent level of injury to their abdominal due the pressure from lap seat belt that pulled them during the impact. The level of injury is believed to be lower if the seat was equipped in three point seat belt so that the pressure can distribute in the chest also rather than abdominal only.

Significant Factors

TARC determined that the probable cause of the 130801-01 case was due to the speeding of the truck and roadway geometry. Also, the unawareness of the vehicle turning to the gas station was also one of the main factors for the accident. Similarly, TARC also determined the probable cause of injury as the retention system plays key role to increases the injuries level of the occupant in every seat in the van.