

Case ID: 060811-01

Accident Narrative

At about 07:00 on Thursday, 11 August 2006, a family left Ayutthaya province, planning to join their relative's funeral at Chiang Yeun in Mahasarakham. At about 06:30 on Friday, 11 August 2006, 11.5 hours later, the pickup that was traveling eastbound on Highway no. 209, a four-lane divided highway, near Chiang Yeun, Mahasarakham (**Figure 3-1**), lost control and rolled over by crossing the median into the westbound lane. The vehicle finally stopped on wheel position, facing westbound. **Figure 3-2** shows the major events of the crash.



Figure 3-1: Accident Location

One of the passengers of the pickup informed the TARC team that he felt the vehicle shaking in a second and started sliding to its right. The vehicle suddenly rolled over on its left. All the passengers in the pickup were ejected, including himself.

From twelve passengers, three suffered serious injuries and eight suffered slight injuries. Two of the serious injuries were referred to Khon Kaen Hospital, while the other ones were treated at Chiang Yeun Hospital and released that day.

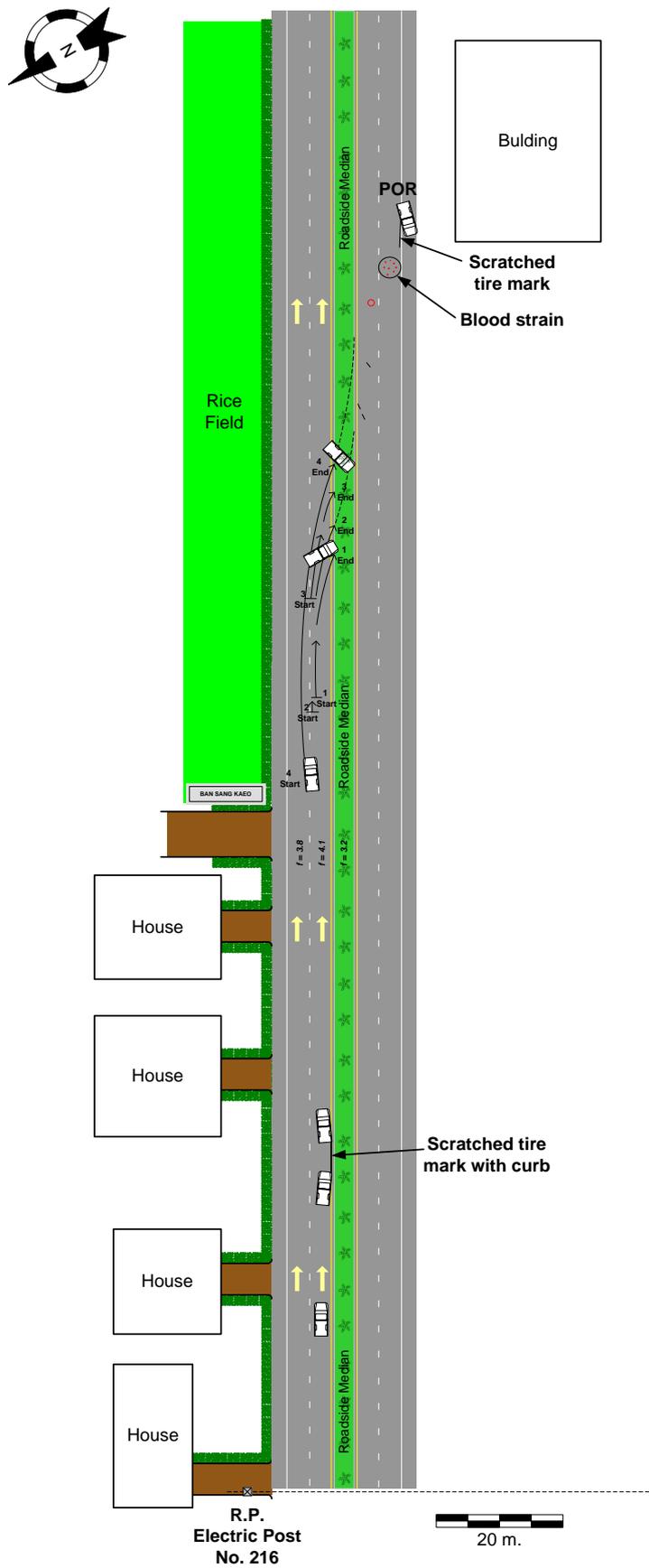


Figure 3-2: Schematic of Accident Scene

Vehicle Information

V1, the pickup, was a Ford Ranger, 2,500 CC. diesel engine, a 5 speed manual transmission, and rear-wheel driven. The wheel base was 2.98 m and the dimensions were 5.07 m. long, 1.72 m. wide, and 1.62 m. high. **Table 3-1** reviews the vehicle's dimensions in details. The tires on the crashed vehicle were Bridgestone Leo 75, 205/75 R 14C, 109/107 C. The post-crash tire pressure measured 46, 46, 44, 42 psi for the front-left, front right, rear-left, and rear-right, respectively.

Table 3-1: Tires Details

Tire	Damage	Manufacture	Tire Name	Size	Pressure (psi)
1L	Rim broken partly	Bridgestone	Leo 75	205/75 R 14C	46
1R	No	Bridgestone	Leo 75	205/75 R 14C	46
2L	No	Bridgestone	Leo 75	205/75 R 14C	44
2R	No	Bridgestone	Leo 75	205/75 R 14C	42

The vehicle was designed for two bucket seats for the driver and front passenger. Both seats were equipped with lap-shoulder belts. The cab, space behind the front seats, was equipped with a bench. The safety beam was fitted inside on both side of the pickup.

Pickup Damage

The exterior damage of V1 shows mostly on the top-right of the vehicle (**Figure 3-3**). The roof particularly the top connecting right A-pillar on the driver's position was indented. The A, B, and C pillars were bent inwardly, which also caused the broken windshield originating diagonally from the top of right A-pillar. Several scratch marks were found on the front-right part of vehicle's body. The front-right signal light loosened from its original position, hanging by the electrical wires. The rear window at the cab was also damaged. The front-left wheel showed damages on the rim. It was partly broken, see **Figure 3-3**. TARC evaluated the Collision Deformation Code (CDC) for the pickup as **02TY1HO5**. **Figure 3-4** shows the extent of damage of V1.



Figure 3-3: The Damage to the Pickup



Figure 3-4: The damage on Front-Left Wheel

Highway Information

The accident occurred on the east- and westbound lane of Highway number 209 in Chiang Yeun which runs between Khon Kaen and Kalasin. The straight-level section of the two lanes eastbound and the two lanes westbound are divided by a 4.1 m. raised median, as shown in **Figure 3-5**. All lanes are 3.6 meters wide, with a 2.4 meter outside shoulder. The asphalt pavement had a coefficient of friction of 0.82 for the 1nd lane and 0.76 for the 2nd lane with a 3.33 % crown slope.

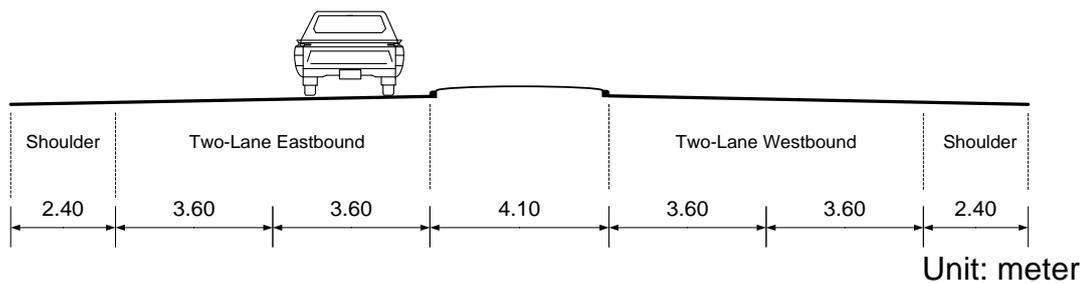


Figure 3-5: Highway Number 209 Cross Section at the Crash Scene

Raised Median

The raised median was constructed as a concrete curb at the middle of two opposing traffic along the roadway. It is located about 30 cm. apart from the yellow-inner lane line, with 4.1 m. in total width. The height of the curb was 15 cm., as shown in **Figure 3-6**, from the road surface. It was filled with soil and covered by grass. The coefficient of friction shows 0.64.

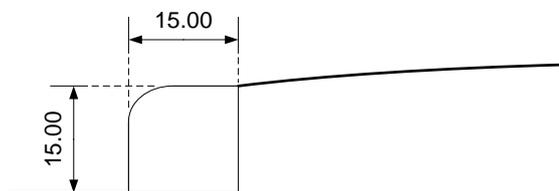


Figure 3-6: Raised Median at Crash Scene

Physical Evidence

The four clear tire marks were documented during the investigation, both on the pavement and median. All evidences were measured and documented as shown in **Figure 3-7**.

The electric pole number 216 was selected as a reference point. The first mark showed on the median curve. The black mark, scratch from vehicle-right tire, was about 6.1 m. in

length, 50.5 m. from the reference point. The four-tire marks, yaw marks, continued 56.2 m. further.

After a close investigation of the yaw marks, each mark was identified as corresponding to the vehicle's wheels. Considering the characteristics of the vehicle rotation about its vertical axis, it rotated clockwise in this crash. The left-most mark, started from the second lane (outer lane) as shown as the rear-left wheel (mark number 4) in the **Figure 3-7**. Next, the mark printed parallel to the rear-left tire would be rear-right tire since they were on the same axle. The same for the other two marks (mark number 3 and 1) were the front-left and front-right, respectively. To use these parameters of tire mark geometry in the mathematical calculation, the chord lengths and middle ordinates were required. **Table 3-2** shows the information about the yaw marks on each wheel.

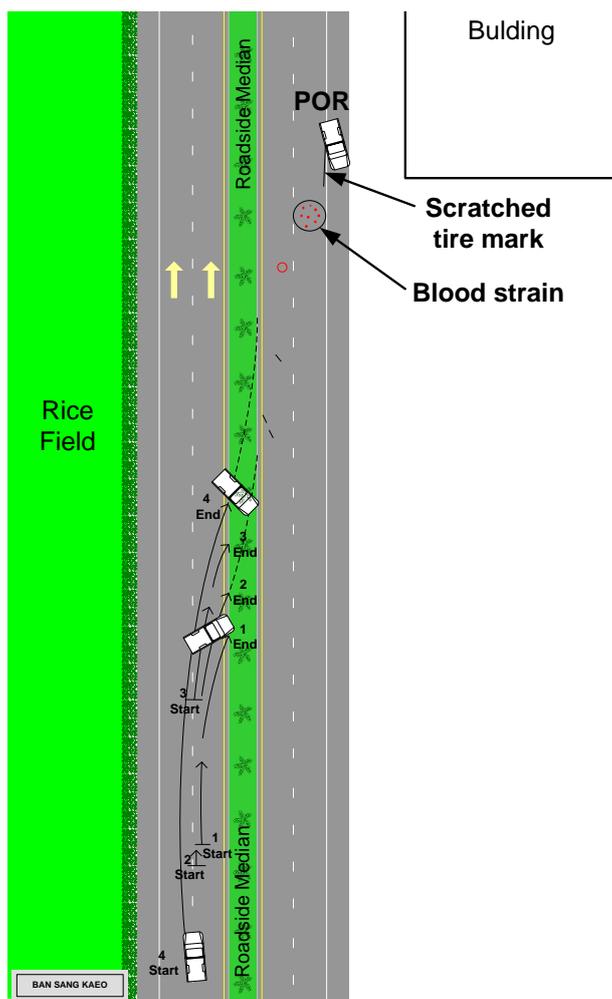


Figure 3-7: Evidences Found at the Crash Scene

Table 3-2: Yaw mark investigation

Mark No.	Wheel	Chord Length (m)	Middle Ordinate (m)
1	Front Left	24.3	1.0
2	Rear Right	31.1	0.9
3	Front Right	27.4	0.4
4	Rear Left	51.8	2.7

The point of rest of the vehicle was estimated according to police photos and evidence on the road. Point of Rest located 188.7 m. from the reference point, heading west.

Injuries information

There were a total of 13 persons in the pickup. Out of 12 passengers, two were sitting in the front left seat (a 10 years old boy was on an adult's lap), four in the cab and six passengers were sitting in the cargo compartment (without covered roof). All passengers in the cargo compartment were ejected from the pick up during the rollover situation. In addition, there was no seat-belt installed in the cab. There was one seriously injured person in the cab and two seriously injured persons in the cargo compartment.

The other seats, including the extended cab had no restraint system. **Table 3-3** and **Figure 3-8** show the occupants' injuries and restraint system on his/her seats. The injuries were coded in ICD10 standard.

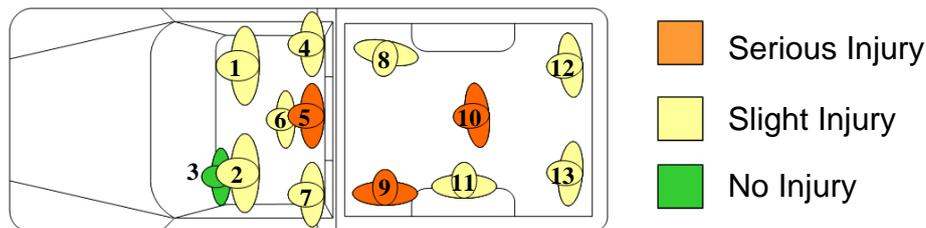


Figure 3-8: Occupants' Seating Position

Table 3-3: Summary of Occupant Injuries

Person Number	Restraint Use	Severity	ICD10	Injury
P1	Lap-shoulder seatbelt	Slight	S01.0	Open wound of scalp
			S60.2	Contusion of other parts of wrist and hand
			S13.4	Sprain and strain of cervical spine
P2	Lap-shoulder seatbelt	Slight	S10.0	Contusion of throat
P3	No	No Injury		
P4	No	Slight	S40.0	Contusion of shoulder and upper arm
			S80.0	Contusion of knee
			S20.2	Contusion of thorax
P5	No	Serious	S00.8	Superficial injury to the other parts of head
			S32.7	Multiple fractures of lumbar spine and pelvis
			S00.8	Superficial injury to the other parts of head
P6	No	Slight	S90.3	Contusion of other and unspecified parts of foot
P7	No	Slight	S20.2	Contusion of thorax
			S00.4	Superficial injury to the ear
			S50.8	Other superficial injuries to the forearm
P8	No	Slight	S60.8	Other superficial injuries to the wrist and hand
			S00.0	Superficial injury to the scalp
			S80.0	Contusion of knee
			S50.0	Contusion of elbow
			S90.3	Contusion of other and unspecified parts of foot
			S82.2	Fracture of shaft of tibia
P9	No	Serious	S50.0	Contusion of elbow
P10	No	Serious	S36.9	Injury to the unspecified intra-abdominal organ
P11	No	Slight	S70.1	Contusion of thigh
			S60.2	Contusion of other parts of wrist and hand
			S90.3	Contusion of other and unspecified parts of foot
			S90.1	Contusion of toe(s) without damage to nail
			S90.3	Contusion of other and unspecified parts of foot
P12	No	Slight	S80.0	Contusion of knee
			S50.0	Contusion of elbow
			S60.2	Contusion of other parts of wrist and hand
			S90.3	Contusion of other and unspecified parts of foot
			S60.2	Contusion of other parts of wrist and hand
P13	No	Slight	S90.3	Contusion of other and unspecified parts of foot
			S10.0	Contusion of throat

Accident Contributing Factors

Long Hours of Driving

The driver started his journey from Ayutthaya at about 19:00. The crash happened in the early morning, at around 06:30. He had been driving for roughly 11.5 hours before the crash occurred. No alcohol related to driving was found during the interview and from medical reports. **Figure 3-9** shows the travelled route prior to the crash. The graphic chart of driving hours is shown in **Figure 3-10**.

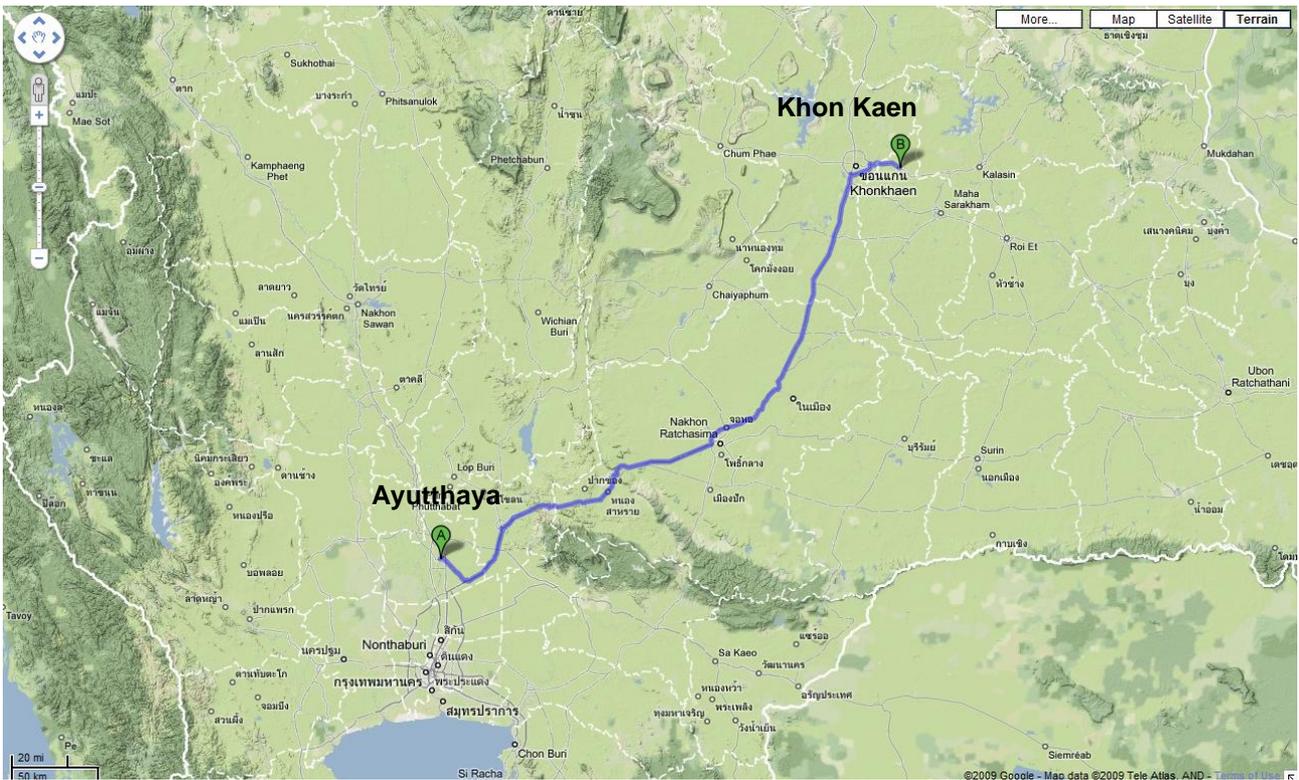


Figure 3-9: Traveled route



Figure 3-10: The Pickup Travelling Hour

Long Straight Road-section

The driver lost the control of regular driving on the straight section of the road. As shown in **Figure 3-11**, the last ten kilometers has only one regular curve, 4.4 km. upstream from the accident scene. The road surface was asphalt and found dry with a friction coefficient 0.82 and 0.76 for the inner and outer lane respectively. The straight section was level grade with a cross slope of 3%.



Figure 3-11: Long Straight Section of Highway Number 209

Evasive Maneuver

After hitting the median curb at first, the pickup came left inside the road and traveled a short distance on the inner lane. Again losing control, the pick went into the raised median. The inattentive driving behavior could be illustrated in **Figure 3-12**, evidence gathered from the road surface and hit marks with the curb. However, the driver could have other alternatives to control the vehicle (e.g. decelerating by braking) to maintain its regular driving again.



Figure 3-12: Evidence of Driving Behavior from Road Surface

Rollover

The vehicle ended up in a roll-over in the median leaving four long yaw marks on the road surface. It was in high speed during the rollover situation and went into the opposite direction of the road, making one-full turn (360°). The orientation of the tire marks as well as the damage of the rim on the front-left wheel supported that the vehicle had been rolled over by its left. The final rest position of the pickup was on its four wheels near the shoulder of the opposite direction road, facing the opposite of its initial travel direction. **Figure 3-13** shows the path of the vehicle during the rollover occurrence.



Figure 3-13: Rollover Evidence and Final Rest Position on the Opposing Traffic Road

Yaw-mark Analysis

There were four yaw marks found during the investigation left by the four tires of the pickup. The yaw marks analysis considering the geometry of marks (i.e. chord length, middle ordinate, and radius) and the road surface conditions (i.e. friction, cross-slope) was conducted to determine the maximum cornering speed of the vehicle at the yaw.



Figure 3-14: Yaw Marks Analysis Considering its Geometry

Considering the chord length, middle ordinate of all four yaw marks the maximum cornering speed was estimated as follows.

Table 3-4: Coefficient of Friction Measurement

Type of Surface	Lane	Co-efficient of Friction	Remarks
Asphalt	Inner lane	0.82	Measured along the tire marks
	Outer lane	0.76	Measured along the tire marks

- Cross slope (e) = 3% = 0.03
- Acceleration due to Gravity, g = 9.81 m/s²

- Radius of Curvature, $R = \frac{C^2}{8M} + \frac{M}{2}$, where C = chord length and M = middle ordinate
- Critical speed at yaw, $V_{critical} = \frac{\sqrt{g \times R \times (f + e)}}{\sqrt{1 - f \times e}}$, when e is between $\pm 10\%$
- Co-efficient of Friction, $f_{eqv} = (\text{percent of length in inner lane} \times f_{inner \text{ lane}}) + (\text{percent of length in outer lane}) \times f_{outer \text{ lane}}$

Assumptions

1. Since tire marks particularly the front-left were made partly on the inner lane and outer lane on the asphalt surface, an equivalent coefficient friction is estimated considering the respective length on the inner and outer lane.
2. The cross slope is considered uniform along the yaw marks, since the starting of the yaw marks found from the cross slope of 3% (e = 0.03).

Table 3-5: Results of Critical Speed from Trajectory Analysis

Tire	Middle Ordinate (m)	Chord Length (m)	Friction, f	Radius of Curvature, R (m)	Yaw in Positive Grade: Critical Speed (km/hr)
Front Left	1.0	24.3	0.82	74.31	91.00
Front Right	0.4	27.4	0.82	94.81	102.78
Rear Left	2.7	51.8	0.81	198.15	147.51
Rear Right	0.9	31.1	0.82	134.78	122.55

Significant Factors

Thailand Accident Research Center determined the probable cause of the 060811-01 crash was the lack of attention of the pickup's driver due to the long hours of traveling. The scratch marks on the median curb on the long straight section made by the vehicle's wheels, without any defect from the vehicle supported that the loss of control of the vehicle was the result of drowsy driving. The over steering in the recovery maneuver caused the vehicle to rollover which contributed to the severity of the injuries.