Case ID: 060829-01

Accident Narrative

At about 14:00 on the rainy Tuesday, 29 August 2006, a pickup traveling eastbound on Highway No.12, a four-lane divided highway, from Ban Fang, Khon Kaen (**Figure 3-1**), and lost control and rolled over into a ditch. The pickup driver informed that he lost control after approaching surface water due to rain on the second lane after trying to overtake a slower van on the 1st lane. The pickup made a complete one turn rollover before hitting the electric pole. The vehicle finally, stopped on its left side, heading north. The driver had no injury while the front passenger suffered serious injuries to the head. **Figure 3-2** shows the major events of the crash.

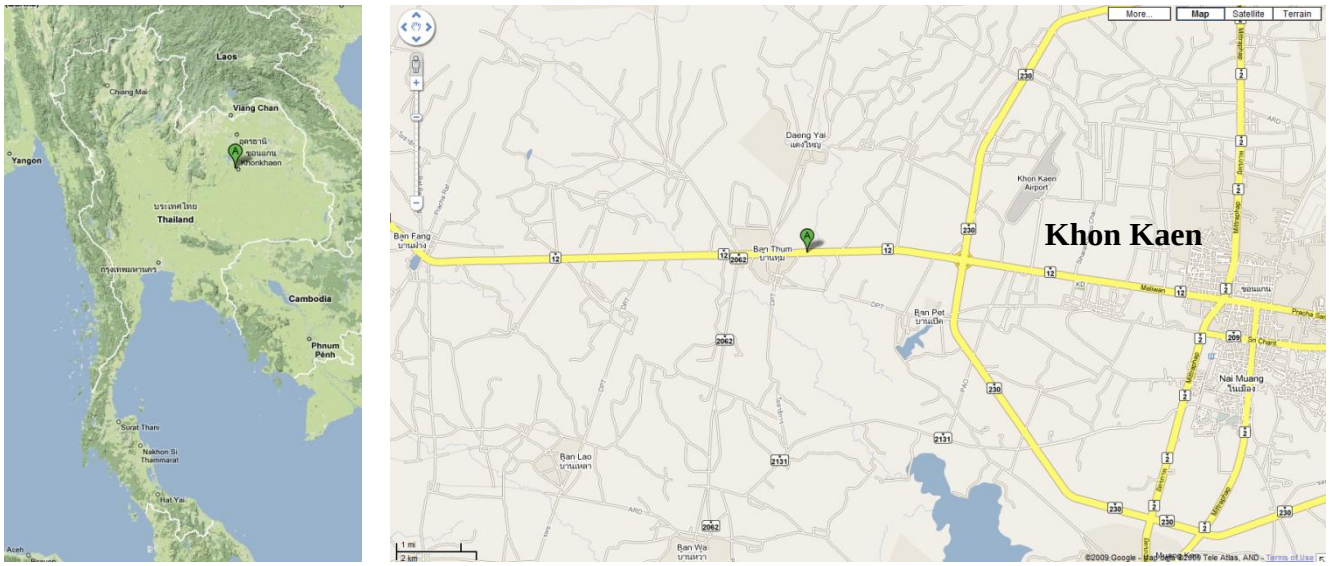

Figure 3-1: Accident Location

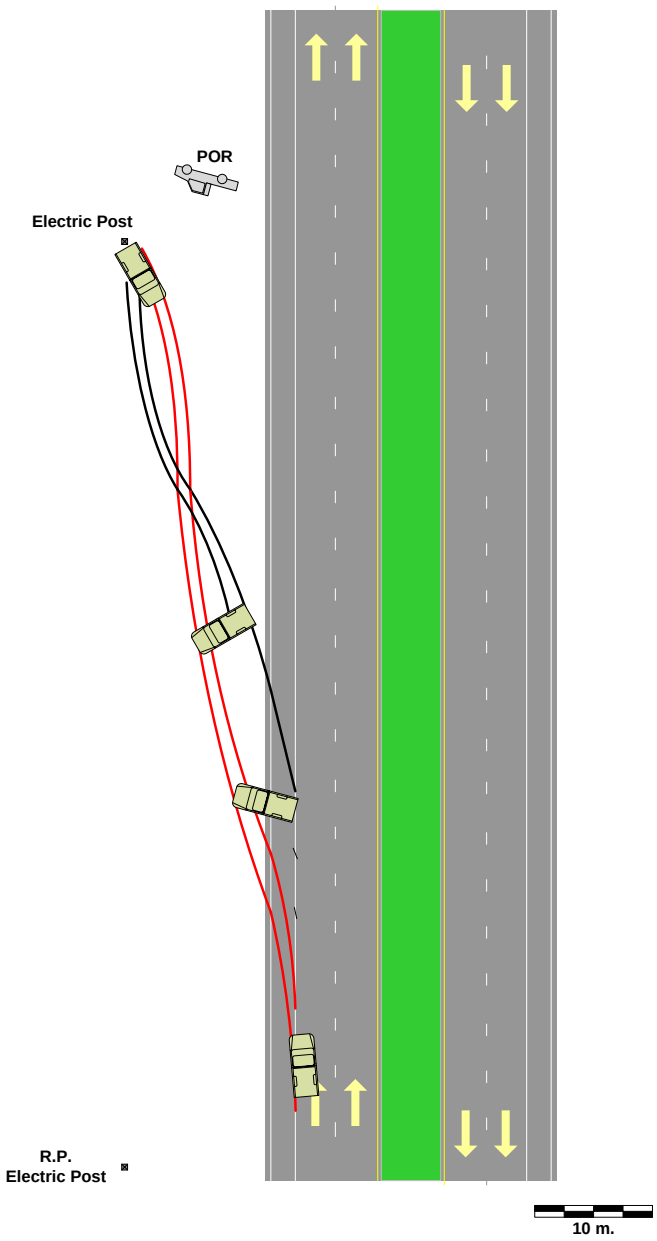

Figure 3-2: Schematic of Accident Scene

Vehicle Information

V1, the pickup, was a 2005 Toyota Hilux D4D Vigo, 3,000 CC. diesel engine with 5 speed manual transmission, and rear-wheel driven. The wheel base was 3.08 m., 5.13 m. in total length, and 1.68 m. in total height, as shown the detail in **Table 3-1**.

Table 3-1: Pickup Dimensions and Weight

Item	Dimension
Overall Length	513.0 cm
Width	176.0 cm
Height	168.0 cm
Wheelbase	308.5 cm
Curb Weight	1530.0 kg

The vehicle was designed for two split 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 post crash vehicle showed substantial damage on its roof (**Figure 3-3**). The roof of the pickup was entirely deflected downwards, damaging the A-pillar that supported the roof. Several intrusions were found also on the left side of the vehicle's body, including the part above the front-left wheel, left door, and cab compartment. The front bumper was deformed directly on the left.

However, there was also massive damage at the rear part of the vehicle (**Figure 3-4**). The rear-right corner was crushed inwardly. The vehicle's body between the occupant's compartment and the pickup was displaced, it moved rightward, deflected from its original position. **Figure 3-5** shows the alignment of the vehicle on the right side. After closely measuring the crush on the rear-right corner, examining the crash scene, and discussing with the driver, it was found that the vehicle had hit the concrete electric pole before stopping at the rest position.

TARC evaluated the Collision Deformation Code (CDC) for the pickup as **12TY1GO2** for roof deformation and **06BD0EN2** for rear deformation.

Figure 3-3: Damage on the Vehicle Roof

Figure 3-4: Damage to the Rear of the Pickup

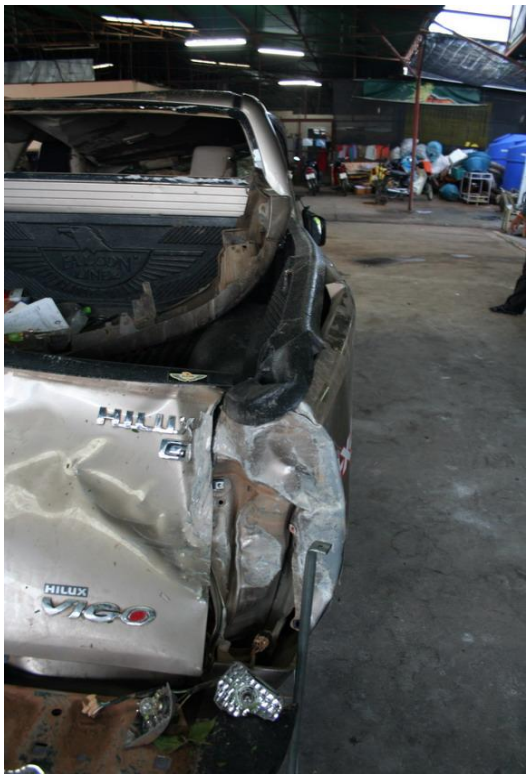

Figure 3-5: Vehicle was displaced on its right

Driver Information

The V1 driver was a 51 years old male, the vehicle's owner. He had been driving for about an hour before the accident occurred with about an hour remaining to reach the destination, as the graphic illustrates in **Figure 3-6**. He had an experience of one and a half year for this vehicle and more than thirty years for pickups. He used to use this pickup daily, while rarely traveling on this route, about eight trips a year.

Figure 3-6: Pickup Travelling Hour

The driver described the crash events to the TARC staff. While he was traveling eastbound on the 2nd lane (outer lane), he tried to speed up to overtake a van on the first lane. The vehicle suddenly ran on the thin film of rain-water accumulated on the road surface after the rain. The vehicle lost control and went into the ditch. It made a complete one turn roll over and hit a concrete electric pole. The pickup rebounded from the electric pole and stopped by its left in the middle of the ditch.

Highway Information

The accident occurred in the eastbound direction of Highway No. 12 between Ban Fang and Khon Kaen municipality. The straight-level section of the two lanes eastbound and the two lanes westbound were divided by a raised median. All lanes were 3.6 m. wide, with a 2.1 m. outside shoulder. The asphalt pavement during the investigation had a coefficient of friction of 0.52-0.6 with a 1.3% crown slope.

Roadside Embankment

The grassy soft clay roadside embankment had a slope of 4:1. It had 16 m of total width. The embankment profile is shown in **Figure 3-7**.

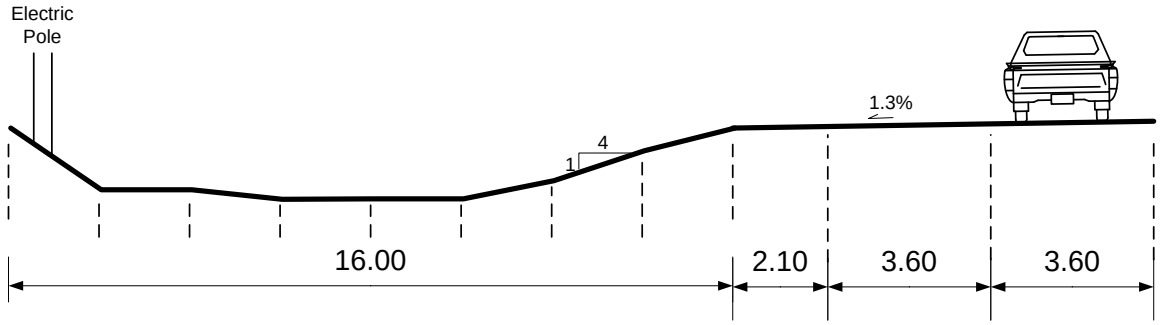

Figure 3-7: Roadside Embankment at Crash Scene

Physical Evidence

The vehicle's traveling path was clearly shown on the wet road surface. The pickup left the roadside 4.8 m. after the reference point, from its right. It started rolling over near the cross-over of the tire mark between the front and rear axles. The path showed that the pickup continued to move towards an electric pole.

Figure 3-8: Rollover Orientation

By closely examining the electric pole, some damaged parts from the vehicle were found, including the right turning signal, braking light, and turning signal. The mark on the electric pole printed by the vehicle's paint was found at a 1.50 m. height from the ground, as shown in **Figure 3-9**.

Figure 3-9: Evidence found at the Electric Pole

Figure 3-10 shows that the excavated gouge at the bottom of the electric pole matched with the gouge soil stuck around the rear-left corner of the car.

Figure 3-10: Crash Position with the Electric Pole

Injuries Information

Both the driver and passenger admitted to have been wearing a lap-shoulder seat belt. The driver had not suffered any injuries while the front passenger suffered serious injuries to her head, an open wound of the scalp and sprain on her spine also.

The interior damage at the front showed blood stains on the front passenger hand-hold fitted on the roof near the passenger door, at a height of 70 cm from the seat after the crash (**Figure 3-11**). Blood was also spread into the bent passenger sun visor. The deformed roof remained 62 cm. high, measured from the seat (**Figure 3-12**). The detail of victims' injuries is shown in **Table 3-2**.

Figure 3-11: Marks showed on the front passenger's seat

Figure 3-12: Deformed Roof Interior

Table 3-2: The Summary of Occupants' Injuries

Person Number	Restraint Use	Severity	ICD10	Injury	Source of Injuries
P1	Lap-should seatbelt	No Injury	-	-	
P2	Lap-should seatbelt	Serious	S01.0 S13.4	Open wound of scalp Sprain and strain of cervical spine	Passenger handhold Rollover movement

Accident Contributing Factors

The analysis part discusses the significant factors causing the crash and injuries. The details gathered from the crash scene and interview, will be raised as an issue. The findings and significant factors, finally, are concluded.

Wet Surface

There was a small film of rain-water (i.e. slash) on the surface, as presented in **Figure 3-13**. The slash was found accumulated on the undulated surface near the shoulder of the outer lane. The coefficient of friction was measured as being 0.52-0.60 on the wet surface.

Rain-water Accumulation on Undulated Surface

Thin Water Film on Road Surface

Figure 3-13: Rain water on Poor Road Surface (undulation)

It is very common that a slippery surface will cause more difficulties in regular driving. Several studies have been conducted about the relation between crash and surface conditions. The study from the Transport Department, London, shows that the accidents risk due to vehicles skidding on pavements with a reduction of the friction coefficient of 25%, is 20 times higher. Moreover, if the coefficient of friction of a road is reduced by 50%, accidents risk is 300 times higher (TD, 1994).

Rollover on Roadside Embankment

The pickup was found to have made a 1-full turn and a 0.25-turn with its rest position on its left side, showing that it rotated and spun over three-axis, supported by the marks on the ditch and at the electric pole. The roadside slope, 4:1, was not "errant-friendly" for the loss of control of the vehicle. In addition, due to rain and low lying ditch the water accumulation made the soil softer than usual in the dry season. This soft soil might have caused imbalance of the errant vehicle resulting in roll-over. **Figure 3-14** shows the location of the vehicle rollover after leaving the roadway.

Soft Soil and Water leading to POR

Presence of Water in the Ditch

Figure 3-14: Rollover Position

The study of Synthesis of rollover research by Yusuf Mohamedshah & Forrest Council conducted the characteristic of vehicle rollover accident (Yusuf Mohamedshah & Forrest Council, 1997). One session review the relationship between rollover and roadside slope as follow…

> "Most of the studies in which roadside features were analyzed attempted to determine the cause of rollovers. It was found that embankments, side slopes and ditches were the fixed objects struck most often in rollover crashes. In most rollover cases, the side slopes were flatter than 3:1 and embankment depth was lower than 1.2 m. This might be expected in that steeper slopes are often protected by guardrails, and thus roadside crashes on those locations are more likely to be impacts with the barriers. Indeed, the current guardrail warrant states that if the side slopes are steeper than 3:1 and depth of embankments is greater than or equal to 1.2 m, then guardrails should be provided to prevent rollover crashes. The above findings clearly suggest that (1) perhaps there is a reason to re-examine the current warrants to see if barriers would be warranted on slopes flatter than 3:1, and (2) rollover may not just be a function of degree of side slope, but also the basic design of the slope itself - whether it prevents tripping, etc."

Injuries to the Occupants

The belted driver did not receive any injury. The front belted passenger however, was reported to be seriously injured to the head. The contact point between her head and the vehicle's interior was indicated by blood stains on the passenger's hand-hold and sun visor.

It cannot be concluded that seatbelts were inefficient in this crash. Rollover crashes involve a more complex mechanism than other types of crashes. The study by Ola Bostrom, Yngve Haland, and Pontus Soderstrom, Autoliv Research, of the Seat integrated 3-point belt with

reversed geometry and an inboard torso side-support airbag for improved protection in rollover, shows the comparison of lap-shoulder belt in standard geometry and in reversed geometry (Bostrom et. al, 2005), as shown in **Figure 3-15**.

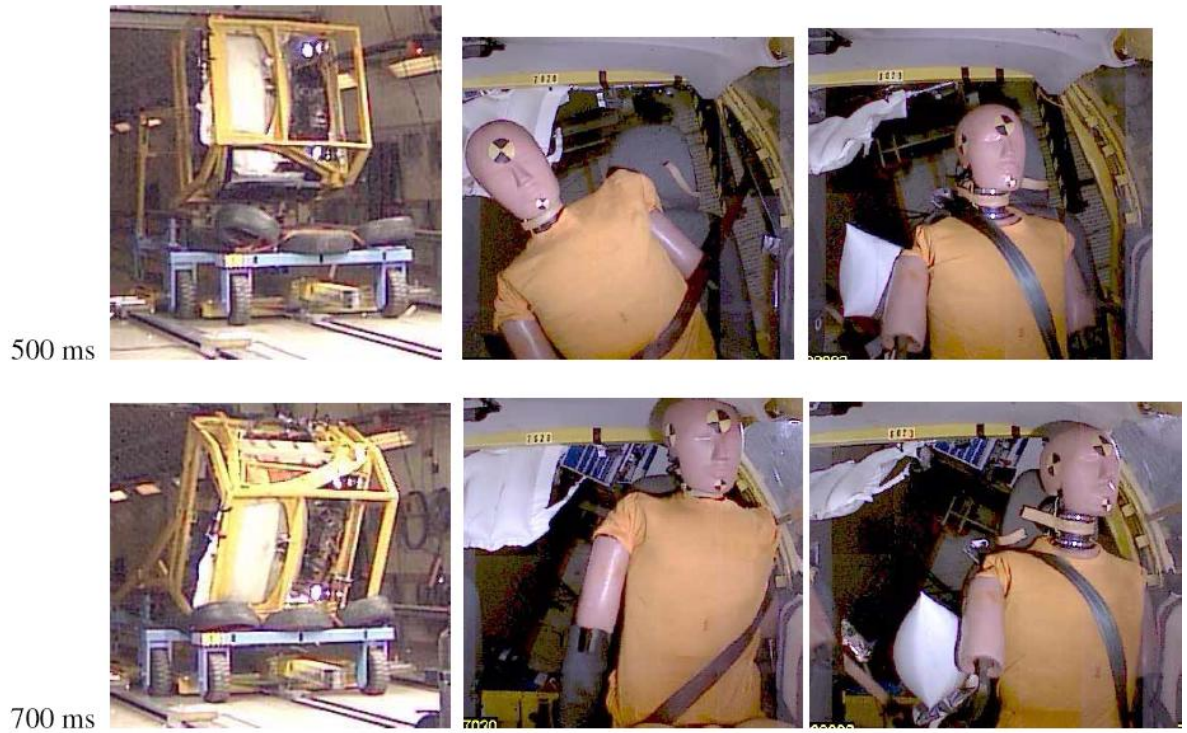

Figure 3-15: Outboard and inboard non-leading occupant views for standard (left) and reversed (right) belt geometry at 500 and 700 ms
Source: Ola Bostrom, Yngve Haland, and Pontus Soderstrom (2005)

From the study, it is observed that the head of the non-leading side (far-side) dummy impacted the inner roof in the standard 3-point belt configuration, the seat integrated 3-point belt with reversed geometry and buckle pretensioner showed the ability to restrain the torso from moving inboard and towards the roof during the rollover tests.

Significant Factor

Thailand Accident Research Center determined that the significant factor of the 060829-01 crash was the improper driving maneuver on the wet surface. The contributing factor to the crash severity was the vehicle rollover into a steep roadside embankment.