ET-Plus Terminal Impact - Evaluation of Its In-Service Performance

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While many official agencies have the capability of informing the public of the safety performance of roadside barriers only Gorski Consulting, without official funding or cooperation, continues to provide that service.

It has been over 1 1/2 years since Gorski Consulting was made aware of certain concerns regarding the safe functioning of ET-Plus guardrail terminals manufactured by Trinity Highway Products of Dallas Texas. Through various news media, primarily in the U.S., we came to understand that there was the possibility that these ET-Plus terminals may be jamming when struck by a wayward vehicle. Instead of jamming they are supposed to allow the length of a guardrail to pass through the terminal and deform such that the collision energy is dissipated in a controlled manner.

Upon hearing of these potential problems Gorski Consulting set out in the fall of 2014 to conduct surveys of the condition of such installations in south-western Ontario. The results of these surveys were presented in articles that were uploaded to the Articles page of the Gorski Consulting website. Since that time Gorski Consulting has uploaded other articles discussing the results from impacted ET-Plus terminals. We have also responded to information released by the U.S. Federal Highway Administration (FHWA) with respect to their claims that the terminals were safe even though a proper and detailed analysis of their in-service performance had not been conducted.

Generally, there has been an air of secrecy and misinformation provided by most official agencies such that a proper, independent evaluation of the performance of the ET-Plus is not available. Without the proper cooperation of authorities Gorski Consulting has taken the initiative to conduct investigations and inquiries within the limits of our capabilities given the fact that in many instances the sites of collisions with these barriers are kept away from the public's view. Thus Gorski Consulting has no way of examining full evidence of the damaged terminals, the damaged vehicles and the injuries caused to those involved in the impacts. The best that can be done is to study terminals before they were impacted and then examine them after an impact and before the evidence of that impact is removed by roadway maintenance personnel.

The present article is a report on such an instance: a terminal that was examined before an impact and an examination of the same terminal after it had been damaged by an impact.

Figure 1 shows the terminal in question located on the south side of Highway 401 just west of the interchange with Highbury Avenue in south London, Ontario. Gorski Consulting examined this terminal on October 14, 2014.

Figure 1: View, looking east, along the south side of Highway 401, just west of Highbury Avenue. This is a view of the ET-Plus terminal that was damaged in an impact a few days prior to January 27, 2016. This view is of its undamaged condition during its examination by Gorski Consulting on October 14, 2014.

There are a number of differences in what we see in Figure 1 versus the set-up when the ET-Plus terminal is involved in compliance testing in a controlled environment. An example of the controlled, compliance test setup is shown in Figures 2, 3 and 4.

As typical, Figure 1 shows that there is a yellow/black hazard marker placed in front of the terminal. The controlled, compliance testing of the ET-Plus does not include the installation of the hazard marker and while such an apparently small object might seem to be of little relevance its effect on the functioning of the system cannot be fully known if it is not present during compliance testing.

As typical, one can also see that there is a significant slope to the right (away from the road) which is also not introduced during compliance testing.

Finally, there is a split in surfaces such that the left side wheels of the striking vehicle would ride on the paved shoulder while the right side wheels of the vehicle would be riding on the grassy slope. Again this is different from the compliance testing as the entrance to impact involves a single, uniform surface.

Figure 2: Example of the compliance test set-up taken from the South West Research Institute's (Texas) re-testing of the ET-Plus in early 2015.

Figure 3: Example of the set-up for compliance testing of the ET-Plus terminal at the South West Research Institute.

Figure 4: Example of the set-up at the compliance testing of the ET-Plus terminal at the South West Research Institute.

Figure 5 shows the head of the ET-Plus terminal which is covered by a black vinyl cover.

Figure 5: View of the ET-Plus terminal showing the black vinyl cover on the head.

Figure 6 shows a side view from the road surface, showing the ET-Plus and its channel and the guardrail on which the terminal is supposed to slide when impacted by a vehicle. On a number of occasions Gorski Consulting has documented that the terminal rests at a significant angle with respect to the rail such that the head is lower and the rear edge of the channel is higher. This angle is not replicated in the controlled testing nor has any comment been made by the manufacturer or the FHWA whether this difference in angle is a concern. In examinations by Gorski Consulting it has been observed that the rear edge of the channel appears to be forced down onto the rail during the initial stage of impact resulting in a dent to the upper edge of the rail. As the rail passes into the head there is a concern that this dented rail will not pass through the head as designed and therefore will jam without allowing the head to ride properly on the rail as designed.

Figure 7 provides a closer side view of the ET-Plus and its channel. It can be seen that the terminal and channel are rotated downward with respect to the angel of the rail. This difference in angle has been seen in many in-service installations during surveys conducted by Gorski Consulting.

Figure 6: Side view of the ET-Plus looking from the road toward the ditch.

Figure 7: Note the substantial difference in horizontal angle between the channel and the rail. This angle difference is not incorporated in the system's compliance testing.

Figure 8 provides a ditch side view of the terminal while in Figure 9 we see its length.

Figure 8: Ditch side view of the ET-Plus terminal.

Figure 9: View looking along the length of the guardrail toward the ET-Plus terminal.

Having established the pre-impact conditions of the installation in the above photos, we then look at the situation after the system sustained impact damage a short time before our examination date of January 27, 2016.

Figure 10 provides an overall view, looking east along Highway 401, toward the location of the damaged system on the south side of the Highbury Ave exit lane.

Figures 11 and 12 provide further, closer views on approach to the damaged system.

Figures 13 and 14 show how the damaged ET-Plus terminal has rotated 90 degrees toward the ditch. This was caused by an obvious kink in the rail near the rear edge of the channel. Such kinking jams the rail from continuing to pass through the terminal head. If the deformation had continued in a more severe impact there is a strong likelihood that the channel would double over the rail such that the channel and terminal head would be facing backwards, and this would produce the reinforced "spear" sometimes referred to in allegations from Mr. Joshua Harmon in his civil suit against Trinity Highway Products. Such a spear has been shown to pierce an impacting vehicle such that the rail enters into the occupant compartment causing injuries to occupants within.

Figure 10: View, looking east, along Highway 401 toward the damaged ET-Plus terminal on the south side of the eastbound exit ramp to Highbury Ave. This photo was taken on January 27, 2016 during an inspection of the system by Gorski Consulting.

Figure 11: View looking east at the damaged ET-Plus terminal.

Figure 12: View looking east at the damaged ET-Plus terminal.

Figure 13: View of the ET-Plus terminal which has rotated 90 degrees toward the ditch.

Figure 14: View of the ET-Plus terminal which has rotated 90 degrees toward the ditch.

Manufacturer's and the FHWA have discussed certain barriers designed to be "gating", or purposely moving away, or breaking away, to allow the vehicle to proceed through it after some energy has been dissipated by the barrier and vehicle damage. It becomes argumentative therefore, when the ET-Plus and its guardrail break away and the rail deforms, as officials claim that the barrier was designed to do what it did. The test to this claim has to be the resulting injuries in an event or the injury potential of what could happen in a more severe impact when the impact is of a lesser severity.

The question in the present case is whether the rail needed to fold over at the point where it did, given the impact severity. One of the factors to consider is how much of the rail passed through the head of the terminal.

Before examining that specific issue there are a number of photographs available that document the condition of the damaged system. Figure 15 provides a view of the terminal head showing that there is more deformation to its right edge and this provides some indication that the impacting vehicle or object may have travelled to the ditch side of the system where it came to rest. Figures 16,17 and 18 show the area where the rail has been extruded through the terminal head. Figure 19 shows the length of the rail and the extent of its deformation. Figure 20 provides a close-up view of the portion of the rail that contains the 90 degree bend.

Now that sufficient documentation has been shown to demonstrate the extent of the damage to the system we need to return to the issue of the extent of energy dissipation that was provided by the length of the rail that passed through the terminal head.

Figure 15: View of the front face of the terminal.

Figure 16: View of the terminal showing the short length of rail that has been extruded out of its side.

Figure 17: View showing the short length of rail that has been extruded through the terminal head.

Figure 18: Top view showing the short length of rail that has been extruded through the terminal head.

Figure 19: View looking west showing the extent of deformation to the rail.

Figure 20: Close-up view of the portion of the rail that contains the 90 degree bend.

The testing at the South West Research Institute in Texas demonstrated the degree to which the impacting vehicle's energy was dissipated by the extrusion of the rail through the terminal head. Returning to the example case shown earlier, the following photos shown how a small Geo Metro struck the ET-Plus terminal in the final compliance test.

In Figure 21 we see the Metro making initial contact with the terminal and then in Figure 22 we see that, after a substantial distance of travel a considerable length of the rail has been extruded through the terminal in a curled state.

Figure 21: View of Geo Metro at initial contact of an ET-Plus terminal during the final compliance test performed at the South West Research Institute.

Figure 22: View of the Metro after it has travelled a considerable distance and has caused a considerable amount of rail to be extruded through the terminal head.

There should be nothing surprising in what we see in Figures 21 and 22 as this is how the system is designed to function. Energy is dissipated primarily through the extrusion of the rail through the terminal head. Note in these two figures that there is essentially no deformation to the remaining length of the rail.

But how does this compare to our scenario of the damaged system on Highway 401? In the real life situation there was very little rail that passed through the terminal head and there was a great deal of deformation in the rail behind the terminal that had not yet passed through the terminal. And if the system had been struck at any higher speed there was no hope that any additional rail would pass through the terminal head because, as we see in the 90 degree bend of the rail, the terminal was already at a 90 degree angle to the length of the rail. Any additional energy that might have existed in a higher severity impact would just result in more deformation of the rail behind the terminal and there would be no additional energy dissipation by extruding the rail through the head. Clearly this real life example shows a reason for concern. It shows that there is a difference between how the system has been shown to perform in the controlled tests at the South West Research Institute and how the system performed in this real life scenario.

The last compliance test at the South West Research Institute provides further reason for concern as the results of that test were determined to be a "Pass" grade such that the system performed as it should. That is an incredible conclusion when on examines what happened in the latter part of the test as shown in the following photos.

Figures 23 through 26 show the results of the compliance test as the Geo Metro rotates and the rail begins to buckle. Here we see that the rail forms a spear that penetrates the driver's side door and enters into the driver's seating space. This is an obvious injury producing consequence whose consequences to a live driver in a real-life collision could be potentially fatal if the wrong set of factors are assembled.

It is incredible that seemingly independent researchers with vast qualifications behind their names would announce to the public that this test was successful. Following the specific guidelines of the NCHIRP-350 this might be the excuse. But clearly, the rail penetrated the driver's door of the Metro and the experts should have raised a large red flag of this dangerous condition, instead of defending the results. Thus this forms one of the grave concerns that those responsible for providing the public with an objective evaluation of the performance of the ET-Plus are not doing so.

Even though we have this inappropriate action of the experts, it still cannot be said whether the ET-Plus is in fact a dangerous installation. Or if it is more dangerous than any other installation that might take its place. Good quality data is required and it needs to be analysed by truly independent experts who are not aligned with one side or another. To date that process has not occurred.

Gorski Consulting will continue to provide objective data about this issue despite the limited opportunity that is available.

Figure 23:The rail begins to buckle the Metro rotates.

Figure 24: The rail continues to buckle as the Metro continues to rotate.

Figure 25: The rail doubles over just behind the terminal forming a spear that penetrates into the driver's door.

Figure 26: As the Metro continues to rotate the rail forms a spear that penetrates the driver's interior.

For the safety of the general public it is essential that corrections be made regarding how road safety data is collected and analysed. Those experts who claim to be independent but have a vested interest in providing a biased analysis must be removed from the process. When an impact of a roadside structure occurs it must be properly documented and that information must be made available to the public so that the hiding of safety problems by persons and agencies that have a vested interest is minimized.

In addition our society must come to grips with the obvious problem that civil litigation hampers our ability to provide an open and honest discussion about issues that affect our safety. When a safety problem exists those who recognize the problem are compelled to adjust their discussion to avoid the potential of being held liable in a subsequent civil suit. While this may be viewed as an acceptable penance for the creation of an unsafe situation, in a majority of instances it creates a necessity to hide facts even though no wrongdoing was involved simply because of the fear that an unreasonable claim may be successful.

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