Nevada Department of Transportation
Specifications Division
Standards and Manuals Section

Position Paper for: Cable barrier systems
Last updated: February 5, 2008

1. **General.** This information is established in consideration of using longitudinal cable barrier systems on Nevada's roads as an alternative to rigid and semi-rigid systems under certain circumstances.
    a. Cable barriers are classified as flexible systems due to their associated high degree of deflection. The flexibility varies among different systems based on the material properties and the configurations of the support posts and cables.
        i. The cables provide the primary resistance to the impact force of an errant vehicle by dissipating energy into the ground at end anchorages. The number, elasticity and tension of the cables affect how the system will behave.
            1. Systems typically have three or four cables. If a fourth cable increases the cost of a system then measurable and warranted compensating benefits should be expected.
            2. Upon sufficient impact a cable will stretch and, if the impact energy is great enough, will not fully return to its original length. Typically, on proprietary systems, the cables are mechanically pre-stretched at the factory to reduce or eliminate this effect.
            3. The cables are mechanically tensioned during the installation of the system to a loading determined by the manufacturer. The loading must be maintained within certain tolerances for the system to remain operational. The method of measuring and adjusting the cable tension and the associated schedule varies among the systems.
        ii. The cable support posts also contribute to the system by creating lateral resistance and dissipating energy into the ground. In general, the closer that the cable support posts are spaced together the less deflection will occur in the system.
    b. Crashworthy end anchorages are only just emerging with at least two currently being in the experimental phase of NCHRP report 350. Other strategies to safely terminate cable barrier systems are available:
        i. Cable barriers can be designed so that the terminal is beyond the clear zone.
        ii. Cable barriers can be designed in conjunction with other longitudinal barrier systems to provide a crashworthy terminal inside the clear zone.

2. **Disadvantages.**
    a. Cost.
        i. Maintenance costs are difficult to assess since damage to road hardware can be recovered from the errant motorist in many cases but in a recent study by the Oregon Department of Transportation such costs to the agency have been estimated at $0.61 per L.F. per year. While this is higher than other systems the study concluded that it is not high enough to offset the low initial cost.
    b. Maintenance.
        i. Cable type systems are generally rendered ineffective by an impact from an encroaching vehicle. This leaves traffic exposed to the shielded hazard in the area of impact until the system can be brought back into service by maintenance forces. This creates an unpredictable scheduling priority for maintenance forces that may not be associated with other types of systems.

ii. NDOT maintenance forces would need to acquire the materials, knowledge and skills necessary to maintain a new type of system.
    1. Cable type systems require periodic re-tensioning of the cables regardless of whether they have been impacted or not.
    2. Cable type systems do not share common materials with our conventional systems such as posts and bolts.
    3. Cable type systems require techniques and knowledge not common to our conventional systems for things such as cable tensioning and end anchoring.

iii. The more intense maintenance requirement results in greater exposure of maintenance forces to live traffic conditions.

c. Performance.

i. Cable type systems deflect much more than our conventional systems. While this factor is taken into consideration when selecting and locating a longitudinal barrier system it does present some other less apparent limitations:
    1. The use of the shielded area for utilities, parking, landscaping, bicycle paths, pedestrian facilities, etc. is reduced.
    2. Transitioning the system into other systems, such as bridge rails and guardrail, is problematic and not well documented.

ii. Currently few crash-worthy end treatments are available for cable type systems. Alternately, the ends can be located beyond the clear zone or be protected with an isolated guardrail type crashworthy end terminal.

iii. The information I have discovered indicates a problem with complete penetration of the system by heavy trucks.

iv. The combination of shoulder width plus deflection area can easily be greater than or equal to the clear zone distance.

v. There is some concern by citizens for the severity of an impact by a motorcyclist with such systems as opposed to smoother, flat surfaced type systems.

d. Location.

i. Cable type systems are generally rendered ineffective by an impact from an encroaching vehicle. This leaves traffic exposed to the shielded hazard in the area of impact until the system can be brought back into service by maintenance forces. To mitigate the added exposure, by reducing the number of impacts, the systems should be placed well away from traffic or in low volume sections.

ii. The average person will not have knowledge of the significantly greater deflection and, therefore, they should not be used in areas where pedestrian traffic is expected.

iii. These systems will not protect motorists as effectively as other systems from rock fall and other hillside debris and, therefore, should not be used in areas where such hazards are a threat to the roadway.

3. Advantages.

a. Cost.

i. The initial installation cost for cable type systems is less than for our conventional types of systems. Recent costs for this type of system include: [a] $9.25 per L.F in Oklahoma, [b] $10.30 per L.F. in Arizona and $8.35 per L.F. in Oregon.

b. Maintenance.

i. Cable type systems are less prone to trap trash and debris.

ii. Cable type systems were reported as being favorable for snow removal in that snow can be pushed through it.

c. Performance

i. Cable type systems have passed TL-3 and TL-4 AASHTO criteria for vehicle impact testing.

ii. Cable type systems result in relatively low forces exerted on vehicle occupants during crashes.
iii. Cable type systems do not create sight distance restrictions.

d. Location
   i. Cable type systems seem to have found their niche as median barriers eliminating or reducing crossover collisions on roadways separated by traversable medians. In this application many of the negative factors of these systems are offset by other factors:
      1. The down time experienced after an impact is not as critical in consideration of the probabilities associated with another encroachment occurring in the same location and resulting in an accident with an oncoming vehicle.
      2. The low severity rating of these systems partially mitigates the cost incurred from impacts by vehicles that would have recovered had a longitudinal barrier not been installed.
      3. In this application the area behind the longitudinal barrier system is not available for other uses regardless of the deflection distance.

4. **Additional information and comments:**
   a. Cable type systems rely on tension in the cables to provide support to the overall system integrity. Installations on the inside of curves would immediately lose cable tension upon impact. The performance of these systems under this condition, especially on small radius curves, is theoretically poor and should be evaluated before such installations are allowed. Usually the post spacing is reduced to mitigate this effect.
   b. Cable type systems do not significantly impede the flow of water and therefore may solve certain problems with conflicting hydraulic and safety issues.
   c. At least one study considered the cable type systems to be aesthetically pleasing.

5. **Position.** NDOT has approved pre-stretched, high tension proprietary cable type longitudinal barrier systems for use as a median barrier for divided highways, when warranted, where the median is at least 24-feet in width and is graded smooth with 6:1 or flatter slopes. Any other use of the system should be based on a benefit to cost comparison with other systems and requires the approval of the Chief Design Engineer.