CIHT Dubai Evening Seminar (Online)

David George

Road Safety Barriers – Principles of Design and Installation

About the Event

As many road safety auditors are aware, there are both theoretical and practical challenges with the design and installation of Road Restraint Systems (or Road Safety Barriers). Some installations can actually make roads less safe if used incorrectly. Skill is therefore required to select the right design solution to maximise safety.

This seminar looked at the types of Road Restraint System used in the UAE and GCC and the various pros and cons of each. Assessing the need, focusing mostly on Abu Dhabi's standard TR-518, was addressed, including calculating Clear Zones. Other options to consider before a Road Restraint System is chosen and installed were also highlighted.

About the Speaker

David George is Road Safety Specialist for Al Ain City Municipality. A specialist in road safety engineering since 1996 he has led teams on road safety audits in the UK, Europe and Middle East, as well as writing, developing and presenting a range of training courses, speaking at conferences, and appearing on television. David is a past Vice-Chair of the Society of Road Safety Auditors, SoRSA.

Presentation

David began by stating that the term Road Restraint System (RRS) is a collective name for all types of safety fence, barrier and parapet. David noted that NCHRP-350 is the previous US standard for RRS performance, now replaced by MASH since 2018. Each type of Road Restraint System has positives and negatives and there is a need to select the type based on the site geometric conditions, design needs and local circumstances. David stated that the "Clear Zone" is the area where 85% of drivers who lose control and leave the road stop within. The Clear Zone is measured from the edge of the travelled lane nearest to the edge of the right of way. The need for Road Restraint Systems depends on speed, gradient and radius of any bend in the road.

The Abu Dhabi Road Design Guide (TR-518), published in 2016, is now used for RRSs in the Emirate and includes guidance rather than definitive standards. Designers should assess each site on a case-by-case basis, applying engineering judgment with justification provided for the final decision. Special considerations need to be taken for RRSs, including proximity of adjacent roads/carriageways, any hazardous materials, areas of high pedestrian activity, cycle lanes, structures and rail lines.

David noted that after identifying the Clear Zone we need to check whether there are any hazards within it. Table 4-1 of the Abu Dhabi Roadside Design guide shows examples of some hazards. David explained that if we see a hazard in the Clear Zone the following options need to be considered:

- Remove the hazard;
- Relocate the hazard;
- Make the hazard passively safe or traversable; and
- Shield the hazard with a longitudinal barrier or crash cushion.

If the hazard cannot be relocated or made safe, then the last option is to protect it with an RRS.

David presented a variety of test levels and crash worthiness descriptions based on NCHRP-350 including TL-3, TL-4 and TL-5. He then explained that The Manual for Assessing Safety Hardware (MASH) sets out guidance based on the size of vehicles, impact speed and impact angles.

A primary type of RRS is a Wire Rope Safety Fence (WRSF). The advantages and disadvantages of the Wire Rope Safety Fence are shown below:

Advantages	Disadvantages
Large deflection reducing impact energy	Larger working width
Lower installation cost	When struck, large sections damaged
Handles different sized vehicles well	Need immediate repair after impact as ineffective
Post replacement usually easy	Cannot be used on tight bends, sag curves or short lengths
Available in TL-4	Breech issues with height/kerbs
Minimal "Sand drop"	Must be installed well

The Strong W-Beam Safety Fence is the most commonly used crash barrier in UAE and Middle East. The advantages and disadvantages of the Strong W-Beam Safety Fence are shown below:

Advantages	Disadvantages
Lower working width	Higher energy transfer to occupants
Less length damaged on impact	Higher cost than flexible systems
Majority TL-3 and TL-4	Breech issues
Generally still has effectiveness after impact	Problems on kerbed roads
Can be used on tighter bends and curves	Sand drop can be a problem

Rigid System (Concrete) Barriers have the following advantages and disadvantages:

Advantages	Disadvantages
No deflection	Higher risk of injury
Majority TL-4 and TL-5	High installation cost
Unlikely to be breached	Sand accumulation
Savings on fatal and serious crashes	Barrier to pedestrians
Relatively maintenance free.	Need special gates for maintenance/emergency crossovers
Lowest whole-life costing	Sand drop issues

David presented some of the factors to consider on the selection of the type of barrier such as working width, likelihood of impact, containment, radius and consequence of breach. These are set out in the table below.

David stated that terminating the length of RRS is one of the most important safety factors and designers need to consider what happens if a driver strikes the terminal. He presented the P4 Style Terminal, which is designed to be struck singularly, deceleration forces are designed not to injure occupants, which must usually be replaced after being struck and which is mostly used for W-Beam safety fences.

Crash Cushion Barrier Terminals are generally on concrete barriers and are more expensive. The Crash Cushion is designed to be struck singularly, with deceleration forces designed not to injury occupants, there is some reset after impact, and it is mostly used where two W- beams meet or at the end of concrete barrier.

Issues	Factors Considered
Working Width	• How much space is free behind the system • Trees, lighting, gantries, signs and structures • Is the ground flat or are there slopes, embankments, rock faces etc.
Likelihood of Strike	• Higher risk of strike at bends and near junctions • If it is struck, flexible systems are of limited protection until repaired • In order to undertake repairs, crews are put in harm's way • Temporary Traffic Management, even when properly implemented is still a risk
Containment	• What is going to hit the barrier and at what speed • Test level on a truck road bridge different to a road where trucks are forbidden • A large SUV at high-speed can breach most flexible or semi-rigid systems
Geometry	• The more flexible the system the more issues there can be on tight bends and curves • Horizontal and vertical radius must be considered • Not all systems work well on all geometries
Consequences	• What happens if a vehicle breaches the system? • What happens if it strikes what is behind the barrier? • Secondary collisions?

WRSF Ramped End Terminals should be designed with care, since the risks of ramped ends are normally very high, WRSP posts are designed to collapse, wire rope ramped ends should not launch vehicles, and any impact will adversely affect the entire run.

David stated clearly that we must prevent vehicles being guided on to more rigid systems/end terminals when passing flexible systems and that wire rope to concrete is one of the biggest dangers in this respect.

The installation and maintenance issues of Road Safety Barriers include turning radius, misalignment, foundation design and snapping rails. Finally David stated that we cannot tell which RRS is the best one since each one has advantages and disadvantages, and we need to choose based on the specific site conditions.

A number of questions were asked with David providing the following commentary.

Questions and Answers

What are the impacts (good or bad) on various systems on motorcyclist compared to car?	In UAE motorcycling is not a significant issue since the volumes are low. Concrete barriers are generally slightly better on motor cyclists since riders slide along them.
Are there experiences of rollover collisions in the verge? A wide-open area in the verge is theoretically best, but is often uneven, with scrub and minor deviations and also shifting sand.	The verge may need to be protected if it was considered a hazard given the speed of the road.
Is it possible to attend Training on Road Restraint Systems in Abu Dhabi?	David was not aware of any training available in RRSs in Abu Dhabi.
If Historic crash data is not available, how we select the particular road constraint system?	The type of Road Restraint System can be related to the road type, anticipated crash types and first principles.
Etihad Rail is expanding quite significantly across UAE. Are there any specific RRS relating to metro/rail corridor or is it simply a natural question of the application of the principles we are talking about particular situation?	In this case consider the worst-case scenario (e.g. UK Hatfield Crash) and design the Road Restraint System for the same.

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