IRF SAFER ROADS BY DESIGN®




expo 2012 vial Argentina

XVI ARGENTINE CONGRESS OF ROAD ADMINISTRATION AND TRAFFIC

7° EXPOVIAL ARGENTINA

OCTOBER 22nd to 26th, 2012

IX INTERNATIONAL CONGRESS OF ITS

XXXVII ASPHALT MEETING

INTERNATIONAL SEMINAR ON CONCRETE PAVEMENT

XXXVII REUNIÓN DEL ASFALTO

ICPA

COMPLEJO FERIAL CÓRDOBA - CITY OF CÓRDOBA- ARGENTINA

TRANSPORT CHALLENGES FACING GROWTH

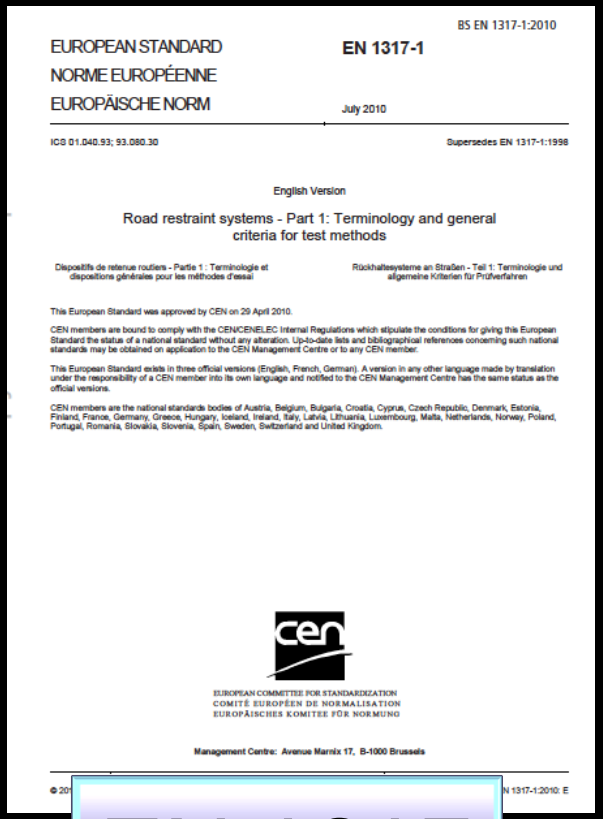
IRF SAFER ROADS BY DESIGN®

COMPARING EN1317 & NCHRP350/MASH

OCTOBER, 2012

CORDOBA, ARGENTINA

Three international methods are used to test roadside safety hardware


BS EN 1317-1:2010

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1317-1

July 2010

ICS 01.040.93; 93.080.30

Supersedes EN 1317-1:1998

English Version

Road restraint systems - Part 1: Terminology and general criteria for test methods

Dispositifs de retenue routiers - Partie 1 : Terminologie et dispositions générales pour les méthodes d'essai

Rückhaltesysteme an Straßen - Teil 1: Terminologie und allgemeine Kriterien für Prüfverfahren

This European Standard was approved by CEN on 29 April 2010.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

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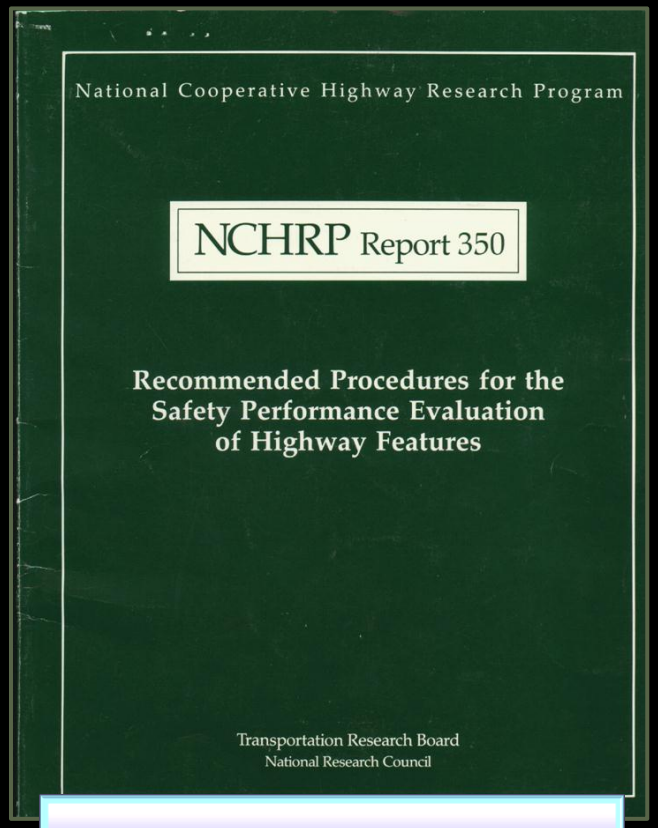
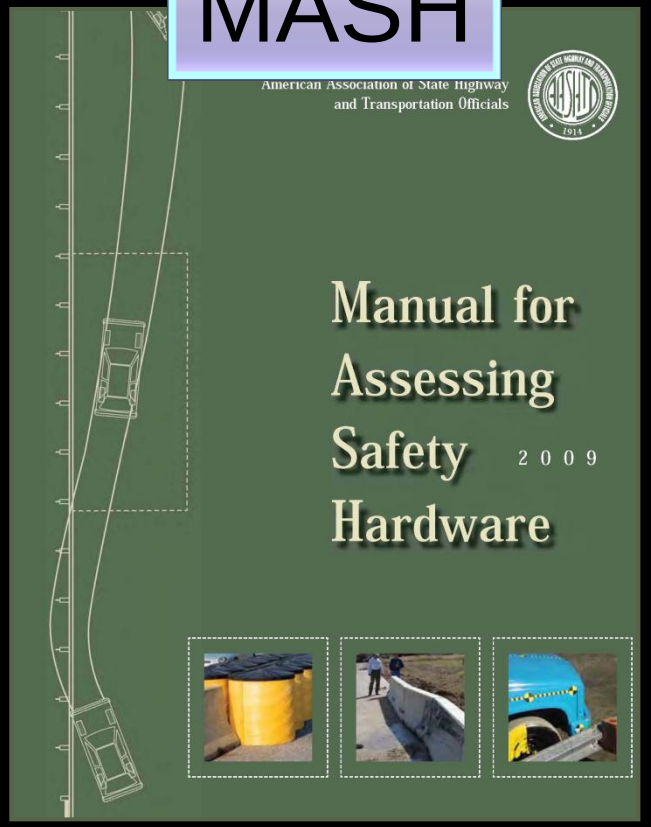
EN 1317



NCHRP 350

MASH



IN 1993 NCHRP 350 WAS

INTRODUCED

NCHRP 350 provides testing procedures for…

Longitudinal Barriers

Transitions

Crash Cushions and Terminals

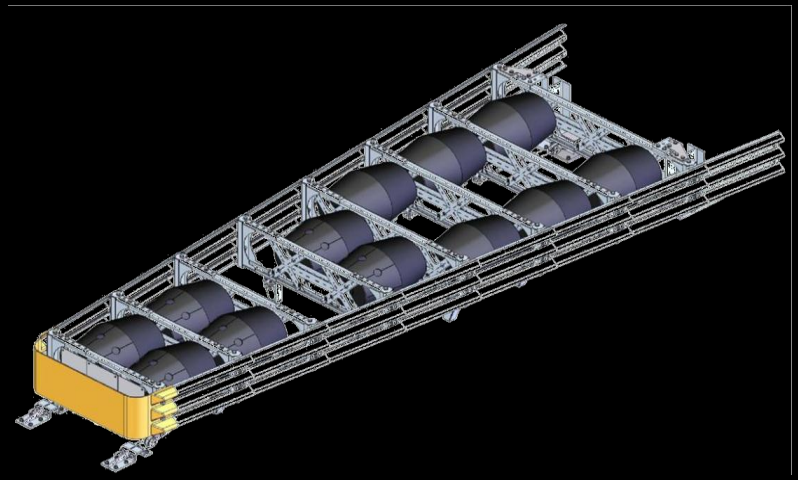
Breakaway or Yielding Supports

Breakaway Utility Poles

Truck Mounted Attenuators (TMAs)

Work Zone Traffic Control Devices

NCHRP 350 affects most road safety products



National Cooperative Highway Research Program

NCHRP Report 350

Recommended Procedures for the Safety Performance Evaluation of Highway Features

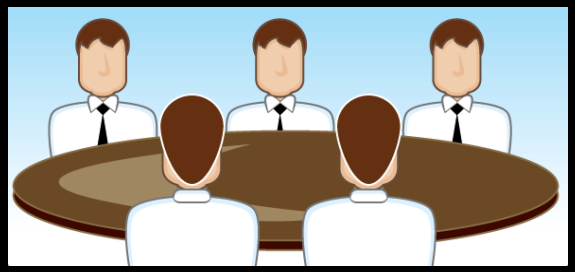
Transportation Research Board
National Research Council

NCHRP REPORT 350
WAS REPLACED BY

MASH

(Manual for Assessing Safety Hardware)

Rewrite/Changes to NCHRP 350



- **MASH is an AASHTO publication, not an NCHRP document. It was published on October 21, 2009.**
- **AASHTO is controlled by the States, not the Federal Government**

Rewrite/Changes to NCHRP 350

- ***Test Vehicles*** **– Update to what's being produced and sold**

Rewrite/Changes to NCHRP 350

- **Test Vehicle Specifications**

Small car increases from 1800# 820 kg to 2420# 1100 kg

1100 C = 2420#

2270 P = 5000#

MASH Light Car (1110 kg - 2425 pounds) Test

Rewrite/Changes to NCHRP 350

- **Test Vehicle Specifications**

Small car increases from 1800# 820 kg to 2420# 1100 kg

Pickup truck increases from 4400# 2000 kg to 5000# 2270kg

1100 C = 2420#

2270 P = 5000#

MASH Heavy Vehicle (2270 kg - 5000 pounds) Test

Rewrite/Changes to NCHRP 350

- **Test Vehicle Specifications**

Small car increases from 1800# 820 kg to 2420# 1100 kg

Pickup truck increases from 4400# 2000 kg to 5000# 2270kg

TL-4 truck increases from 17,600# 7982 kg to22,000#10000kg

1100 C = 2420#

2270 P = 5000#

Rewrite/Changes to NCHRP 350

Revised Test Level 4 (TL-4) Crash Test 90 km/hr, 22, 000 lbs, 15 degrees

Rewrite/Changes to NCHRP 350

- **Test Vehicle Specifications**

Small car increases from 1800# 820 kg to 2420# 1100 kg

Pickup truck increases from 4400# 2000 kg to 5000# 2270kg

TL-4 truck increases from 17,600# 7982 kg to 22,000#10000kg

No longer use vehicles older than 6 years

1100 C = 2420#

2270 P = 5000#

Rewrite/Changes to NCHRP 350

- **Test Vehicle Specifications**

Small car increases from 1800# 820 kg to 2420# 1100 kg

Pickup truck increases from 4400# 2000 kg to 5000# 2270kg

TL-4 truck increases from 17,600# 7982 kg to 22,000#10000kg

No longer use vehicles older than 6 years

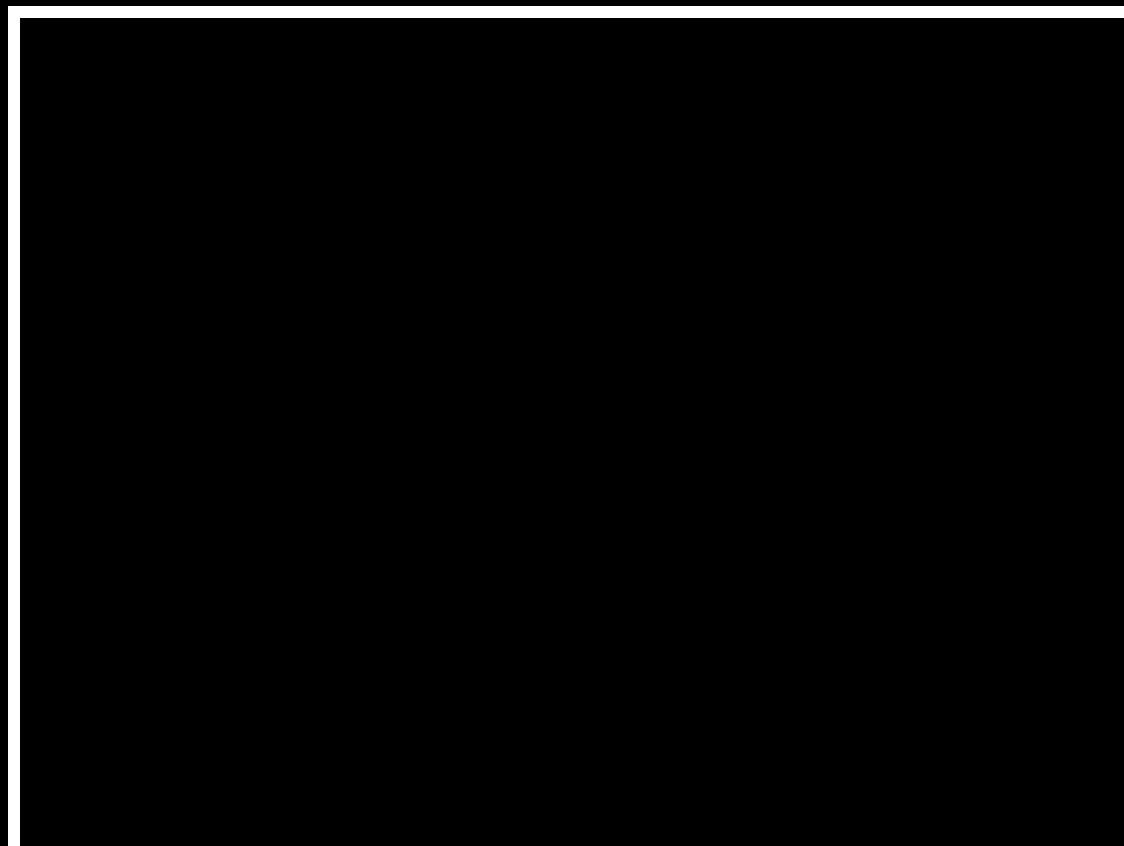
TMA tests on heaviest/lightest support truck

1100 C = 2420#

2270 P = 5000#

Rewrite/Changes to NCHRP 350

TMA tests on heaviest/ lightest support truck.



Rewrite/Changes to NCHRP 350

- **Test Vehicle Specifications**

Small car increases from 1800# 820 kg to 2420# 1100 kg

Pickup truck increases from 4400# 2000 kg to 5000# 2270kg

TL-4 truck increases from 17,600# 7982 kg to 22,000# 9978 kg

No longer use vehicles older than 6 years

TMA tests on heaviest/lightest support truck

Midsize car added (3306# 1500 kg) for staged crash cushions and TMAs

1100 C = 2420# 2270 P = 5000# 10,000 kg = 22,000#

Rewrite/Changes to NCHRP 350

Staged impact attenuators will be required to add a 1500 kg vehicle test

Rewrite/Changes to NCHRP 350

- ***Test Vehicles*** **– Update to what's being produced and sold**
- ***Impact Condition Criteria*** **– Correct inconsistencies & identify needed conditions**

Rewrite/Changes to NCHRP 350

- **Test Installation**
  - **Installation length more definitive (cable barriers).**
  - **Barrier height (max) small car & (min) pickup test.**
  - **Addition of performance based specs for soil.**

Rewrite/Changes to NCHRP 350

- **Test Matrices & Conditions**

Small car impact angle from 20 to 25 degrees

Rewrite/Changes to NCHRP 350

- **Test Matrices & Conditions**

Small car impact angle from 20 to 25 degrees

Terminal/CC impact angle from 20 to 25 degrees

Rewrite/Changes to NCHRP 350

- **Test Matrices & Conditions**

Small car impact angle from 20 to 25 degrees

Terminal/CC impact angle from 20 to 25 degrees

TL-4 truck speed from 80 km/hr to 90 km/hr

Rewrite/Changes to NCHRP 350

- **Test Matrices & Conditions**

Small car impact angle from 20 to 25 degrees

Terminal/CC impact angle from 20 to 25 degrees

TL-4 truck speed from 80 km/hr to 90 km/hr

Var. Mess. Sign / Arrow Board test matrix added

Rewrite/Changes to NCHRP 350

Rewrite/Changes to NCHRP 350

- **Test Matrices & Conditions**

Small car impact angle from 20 to 25 degrees

Terminal/CC impact angle from 20 to 25 degrees

TL-4 truck speed from 80 km/hr to 90 km/hr

Var. Mess. Sign / Arrow Board test matrix added

Temporary Sign Supports add 2270 kg (5000#) vehicle test.

Rewrite/Changes to NCHRP 350

- **Test Matrices & Conditions**

Small car impact angle from 20 to 25 degrees

Terminal/CC impact angle from 20 to 25 degrees

TL-4 truck speed from 80 km/hr to 90 km/hr

Var. Mess. Sign / Arrow Board test matrix added

Temporary Sign Supports add 2270 kg (5000#) vehicle test.

Longitudinal Channelizing Barricade category

Rewrite/Changes to NCHRP 350

Rewrite/Changes to NCHRP 350

- ***Test Vehicles*** **– Update to what's being produced and sold**
- ***Impact Condition Criteria*** **– Correct inconsistencies & identify needed conditions**
- ***Evaluation Criteria*** **– Correct existing subjective criteria & better define other criteria**

Rewrite/Changes to NCHRP 350

- **Evaluation Criteria**

- Windshield damage criteria to be more objective

- Occupant compartment deformation criteria more objective. This is viewed by many as being more lenient. NCHRP 350 failed test may pass MASH

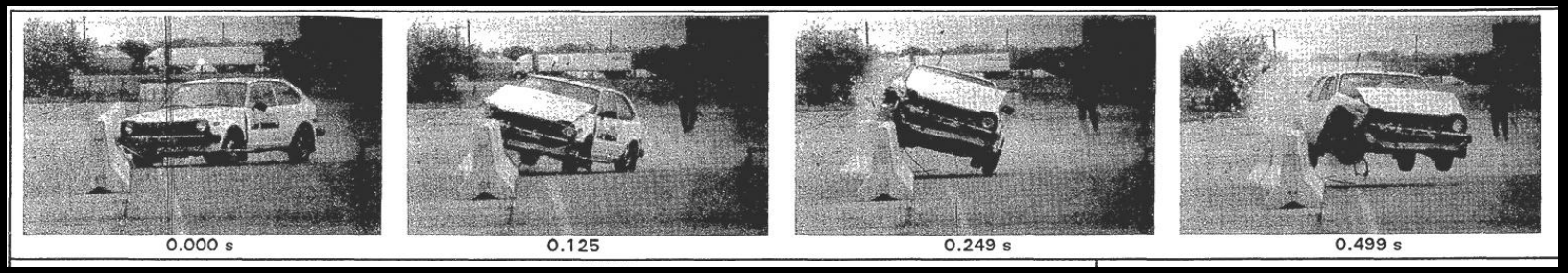
- Maximum roll angle set to 75 degrees

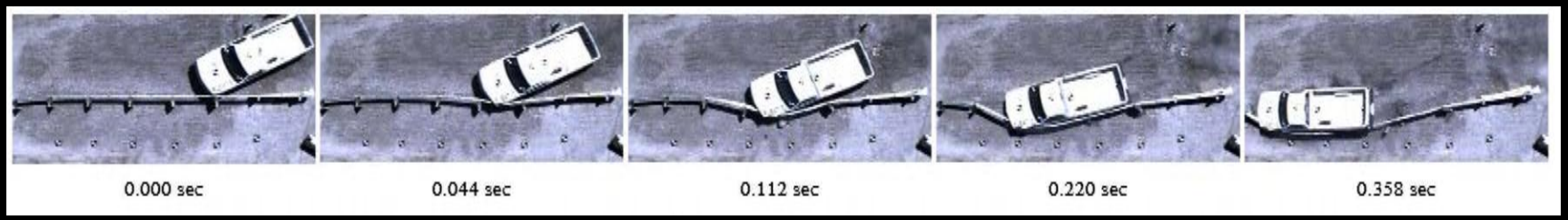
Rewrite/Changes to NCHRP 350

- **Test Documentation**

- More detailed documentation in test report

- More detailed documentation of hardware components





Rewrite/Changes to NCHRP 350

- **In-Service Performance Evaluation**

- Strengthen language to more strongly encourage In-Service Performance Evaluations to be done

SUMMARY OF CHANGES IN MASH FROM NCHRP REPORT 350 PERTAINING TO TEST MATRICES

Topic	Change	Relevancy	Anticipated Impact
Small Car Impact Angle	Increase small car impact angle from 20 to 25 degrees to match the impact angle used with light truck testing.	Accident data show that higher angle impacts are more severe and that small car impact angles are not lower than light truck impact angles.	Some barriers, particularly cable barriers, may not pass the higher angle testing. It is believed that the new testing requirement may result in design changes that would reduce penetration frequencies for these barriers.
Impact Speed for Single Unit Truck Test	Increase impact speed from 80 km/h to 90 km/h.	Single unit truck impact speed was increased to make the TL-4 test more meaningful relative to TL-3.	There is a concern that a 32" high NJ barrier may not meet the proposed TL-4 test conditions. Stiffened barriers will provide greater containment capacity than currently associated with TL-4 systems.
Impact Angle for Length-of-Need Tests of Terminals and Crash Cushions	Increase impact angle for length-of-need testing from 20 to 25 degrees.	The length-of-need test is defined as the point where a system becomes effective as a longitudinal barrier. Hence, the impact angle should be the same as longitudinal barriers. Terminals and crash cushions are usually located farther from the roadway than are longitudinal barriers. Since impact angles increase with greater lateral distance from the roadway, there is no justification for using lower impact angles.	Some terminals or crash cushions will need to be stiffened to provide the additional capacity for the higher impact angle and the frequency of penetrations near the end of barrier systems will be reduced.

LIST OF CHANGES FROM NCHRP REPORT 350 PERTAINING TO **TEST MATRICES** (Continued)

Topic	Change	Relevancy	Anticipated Impact
Oblique End Impacts for Gating Terminals and Crash Cushions	Reduce the impact angle from 15 to 5 degrees.	Full-scale crash testing has shown that the higher impact angle makes gating terminals function better. Anecdotal crash data indicates that low impact angles could lead to rail buckling and penetration of the occupant compartment.	It is anticipated that most crash cushions and terminals will be uneffected. This change would result in post-and-beam terminal and crash cushion designs becoming more resistant to buckling.
Occupant Risk for Length-of-Need Tests	Require length-of-need tests with pickup truck test vehicle to meet occupant risk criteria.	Accident data indicates that more than 15% of all crashes involve impact angles greater than 25 degrees. Barriers should be designed to safely accommodate these impacts.	A very small number of barrier transition systems that exhibit severe snagging during the light truck testing may not meet the new criteria. Redesigning these barrier systems will reduce the risk of severe injury.
Mid-size Car Test	Add head-on test with 1500A test vehicle for staged impact attenuation systems.	There is a need to assure that impact attenuation systems function properly when struck by mid-size vehicles.	Most crash cushions will be exempted from this test through analysis of accelerometer data from 2270P test. Some crash cushions and TMAs may need to be redesigned and the overall length of the systems could increase.
Barrier Testing Heights	Recommend barrier mounting height be set at maximum for small car tests and at minimum for pickup truck tests.	There is a need to verify that specified tolerances on barrier mounting heights are appropriate.	Specified tolerances on mounting heights for some existing barriers may have to be modified or tightened. Designers will have clear demonstration of acceptable barrier mounting heights.

LIST OF CHANGES FROM NCHRP REPORT 350 PERTAINING TO **EVALUATION CRITERIA** (Continued)

Topic	Change	Relevancy	Anticipated Impact
Flail Space Criteria	Require all longitudinal barrier tests to meet flail space criteria.	A large proportion of barrier impacts occur at angles between 15 & 25 deg. Barriers should perform acceptably for these impacts.	Virtually all barriers already meet these criteria. The effects are therefore believed to be limited.
Roll Angle	Set maximum roll and pitch angles to 75 degrees.	Provide objective measure of maximum acceptable risk of rollover.	Provide more consistent and objective evaluation of vehicle stability.
Exit Conditions	Eliminate subjective criteria for evaluation of exit conditions. Require reporting of exit box evaluation criterion. (Note that meeting this criterion is not required for a passing test.)	Improve the consistency in the evaluation of vehicle exit conditions from barrier impacts; promote international harmonization.	Provide better and more consistent assessment of exit conditions.
Vehicle Rebound	Add required documentation to vehicle rebound in crash cushion tests.	Provide better information on vehicle rebound in crash cushion tests.	Provide better information for user agencies on testing of crash cushions with vehicle rebound.
CAD Drawings	Require CAD (AutoCAD or Micro Station) drawings of test device, including key elements, and test installation.	Provide better documentation of the system that was actually crash tested.	Provide better documentation with little additional cost since most testing agencies are already using CAD drawings.
Test Report	Require more detailed documentation of the conduct of the test and the evaluation results.	Provide better documentation of the conduct of the test and the evaluation results.	Require additional time for documentation and provide additional information for potential users of the hardware.

LIST OF CHANGES FROM NCHRP REPORT 350 PERTAINING TO **TEST MATRICES** (Continued)

Topic	Change	Relevancy	Anticipated Impact
Critical Impact Point for small car terminal test.	Define CIP as point where terminal behavior changes from redirection to gating.	Test terminals and redirective crash cushions under more critical condition.	Reduce risk for vehicles impacting between the beginning of the length of need and the end of the device.
Critical Impact Point for Reverse Direction Impacts	Require testing at transition from backup structure to crash cushions.	Anecdotal accident data indicates that reverse direction accidents continue to be a safety problem for a number of crash cushion systems.	The transition elements on the back of some popular crash cushions may need to re-design to preclude serious snagging problems during reverse direction impacts. The frequency of this type of crash will diminish significantly.
TMA Optional Tests	Change the two currently optional tests to mandatory.	These two optional tests have been shown to be good indicators of the impact performance of TMAs and should, therefore, be included as part of the test matrices.	Some existing TMAs may not pass these two previously optional tests and need to be re-designed. Costs for full-scale crash testing of TMAs will be increased; however, most systems already pass these optional tests.
Variable Message Sign and Arrow Board Trailers	Add these items to TMA crash test matrix.	Attenuation systems for these trailers have been developed and a recommended procedure for safety performance evaluation of these systems is needed.	Developers will know the testing required for approval of variable message sign and arrow board trailer attenuation systems.
Support Structures and Work Zone Traffic Control Devices	Add pickup truck test,	Research has demonstrated that support structures and work zone traffic control devices can penetrate through the windshield of light trucks.	Some small sign supports, particularly base bending sign systems, may not meet the new criteria and thereby be forced out of the market. Fewer crashes with sign supports and wok zone traffic control devices will involve objects penetrating the windshield and injuring a motorist.

LIST OF CHANGES FROM NCHRP REPORT 350 PERTAINING TO **TEST MATRICES** (Continued)

Topic	Change	Relevancy	Anticipated Impact
Longitudinal Channelizing Barricades	Add category and recommended test matrix for longitudinal channelizing barricades.	These barricades are being designed and used in the field, but are not covered in the current guidelines.	Developers will have objective evaluation criteria with which to design these systems.
Event Data Recorder (EDR) Data Collection	Collect Event Data Recorder (EDR) and airbag deployment data on test vehicles.	EDR data provide information on impact conditions and acceleration, which can be used to link crash test conditions and results to real-world crashes.	Battery power to test vehicles will have to remain on during testing; require use of sealed, non-volatile battery.

LIST OF CHANGES FROM NCHRP REPORT 350 PERTAINING TO **TEST VEHICLES**

Topic	Change	Relevancy	Anticipated Impact
Test Vehicles	Replace 820C with 1100C Replace 2000P with 2270P	Vehicle fleet size has increased significantly and test vehicles are being revised accordingly.	Increased vehicle masses will place higher impact loads on barrier systems and cause higher deflections. It is believed that most longitudinal barriers will still pass new criteria. Barriers failing the criteria will be strengthened to reduce barrier penetration rates.
Light Truck Test Vehicle	Require 28 in. minimum c.gs height	Most large SUV's have c.g. heights in the 28 to 29 inch range. The new test vehicle will match these very popular vehicles.	Testing to date indicates that, during most longitudinal barrier testing the new test vehicle will be no less stable than the 2000P vehicle. This change will present some difficulties for low height barriers. Raising these barriers will reduce vehicle penetration and rollover rates.
Vehicle Age	Remove option for using older passenger car test vehicles that are structurally similar to current models.	Vehicle designs are changing rapidly and it is impossible to know the impact of seemingly modest changes in vehicle suspension and frame elements.	All testing agencies will be forced to purchase test vehicles that are 6 years old or less. Testing costs may increase slightly. Because most testing agencies have been complying with this requirement, the impact is expected to be very small.
Single Unit Truck Mass	Increase single unit truck from 8000 kg to 10,000 kg.	Single unit truck mass was increased to make the TL-4 test meaningful relative to TL-3.	There is a concern that a 32" high NJ barrier may not meet the proposed TL-4 test conditions. Stiffened barriers will provide greater containment capacity than currently associated with TL-4 systems.

LIST OF CHANGES FROM NCHRP REPORT 350 PERTAINING TO **TEST VEHICLES** (Continued)

Topic	Change	Relevancy	Anticipated Impact
Truck Box Attachment	Require truck box attachments on test vehicles to meet published guidelines for such attachments	Truck boxes have become detached during full-scale crash tests. When this occurs, barrier loading and the risk of vehicle penetration are significantly reduced and the results of the test are unreliable	Requiring consistent attachments between the truck box and the truck frame will reduce the incidence of inconclusive test results without a significant increase in test cost.
Vehicle Damage	Document external vehicle crush using NASS procedures	Documentation of vehicle crush will provide correlation with NASS-CDS crash data base.	Documenting vehicle crush will increase the cost of testing only slightly and provide an important link between crash testing and accident data.
Crushable Nose Characteristics	Develop new crushable nose for use on surrogate test vehicles	Existing crushable nose properties were calibrated against a 1981 Volkswagen Rabbit. This vehicle is more than 24 model years old.	Calibration of a new crushable nose is not expensive and only needs to be conducted once. The new crushable nose will assure correlation between surrogate vehicle testing and full-scale testing.
TMA Support Vehicle	Require TMA developers to select maximum and minimum support truck weight ratings. Three full-scale crash tests will be conducted with the maximum allowable support truck mass and one test will be conducted with the minimum.	Under existing guidelines user agencies are forced to use very light weight support trucks or face tort risk for using vehicle heavier than those used in compliance testing.	User agencies will be able to purchase TMA units tested on support trucks as heavy as those used in service.

LIST OF CHANGES FROM NCHRP REPORT 350 PERTAINING TO TEST INSTALLATION

Topic	Change	Relevancy	Anticipated Impact
Soil Condition	Add performance based specifications (measured soil strength) to the existing material based specifications (soil type, gradation, compaction, density, etc.).	Ensure consistency in soil strength within and among testing agencies	Added costs to conduct in-situ static push/pull tests for initial calibration tests, re-test every two years, and conduct soil strength test prior to construction and prior to testing of each installation. Improved soil strength consistency between testing agencies.
Embedment of Posts	Eliminate lateral width requirement for fill material, which is currently not met by most testing agencies. However, the embedment depth requirement remains.	The requirement for lateral width of fill materials is no longer applicable given the new testing requirement.	Reduce amount of required fill materials.
Splices	Require any rail element splice used in the field to be installed in the impact region during testing	Cable splices are often used in the field, but have not been included in crash testing programs.	Splices used in the field will have been tested to assure adequate performance.
Cable Tension	Require cable tension to be set to value recommended for 100^{o} F.	Assure equal comparison for all cable barriers and reasonable assessment of barrier deflection.	Will allow a direct comparison between tests of different systems.
Components	Require more detailed documentation of components used in the test installation.	Ability to trace the components in case there are questions regarding the test installation.	Requires additional time for documentation.
Installation Length	Add more definitive requirements with regard to minimum installation length.	Ensure that the test installation is of sufficient length to minimize end effects.	May increase cost of construction for a given test installation but will assure a more uniform comparison of barrier performance.

LIST OF CHANGES FROM NCHRP REPORT 350 PERTAINING TO **EVALUATION CRITERIA**

Topic	Change	Relevancy	Anticipated Impact
Windshield Damage Evaluation Criteria	Change the current qualitative or subjective windshield damage evaluation criteria to a more quantitative or objective set of criteria.	Improve the consistency in the evaluation of windshield damage.	Provide more consistent and objective evaluation of windshield damage.
Windshield Damage Evaluation Criteria	Apply windshield damage criteria to permanent support structures as well as work zone traffic control devices.	Raise performance requirements for permanent hardware to meet that associated with work zone traffic control devices.	Assure that permanent hardware is not evaluated to a lower standard of performance than work zone devices. Will require improved performance from some base bending signs.
Occupant Compartment Damage Evaluation Criteria	Change the current qualitative or subjective occupant compartment damage evaluation criteria to a more quantitative or objective set of criteria.	Improve the consistency in the evaluation of occupant compartment damage to bring roadside safety criteria into conformance with vehicle crashworthiness criteria.	Provide more consistent and objective evaluation of occupant compartment damage.
Marginal Pass	Delete use of "marginal" pass, i.e., strictly pass/fail on all evaluation criteria.	Reduce ambiguity from the evaluation.	Provide clearer interpretation of test results.

Topic	Change	Relevancy	Anticipated Impact
Conduct of In-Service Evaluation	Strengthen language emphasizing the importance of in-service performance evaluation.	Promote conduct of in-service evaluation.	Limited.

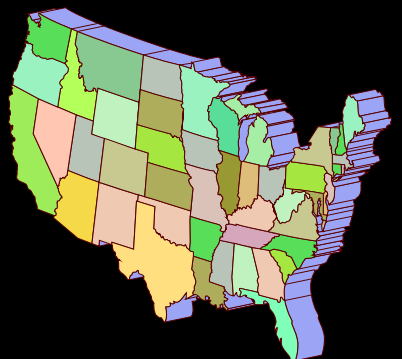
FHWA Implementation

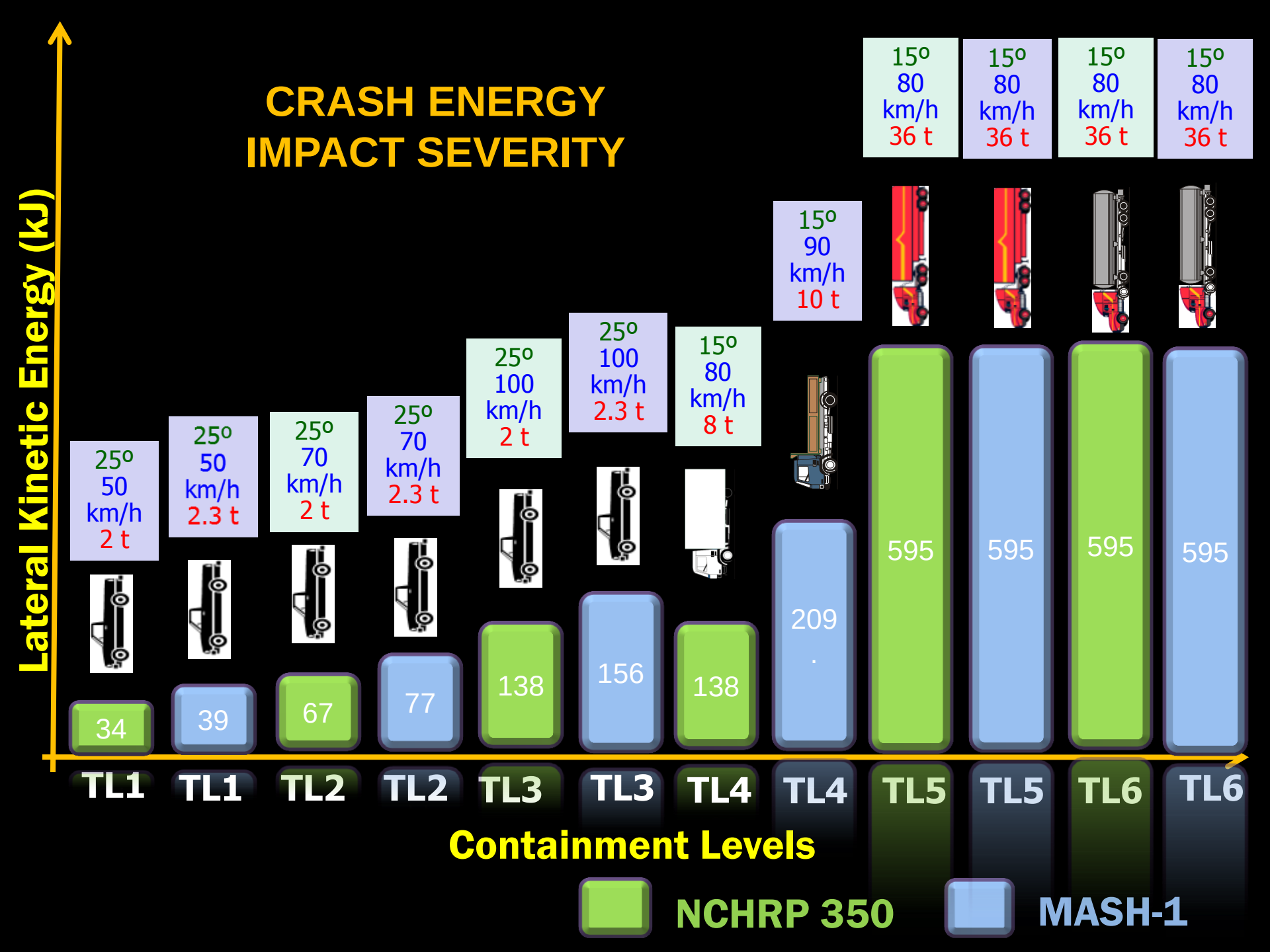
- **Effective October 21, 2009, any new devices (including modifications to NCHRP 350 compliant devices) had to be tested to the MASH criteria.**

- **However, FHWA allowed a grace period that ended on January 1, 2011. During this time, FHWA agreed to review devices for "Eligibility Letters" using NCHRP 350 criteria *"IF"* the test program was started before October 21, 2009. About 40 products were submitted to FHWA for evaluation during December, 2010.**

DOT Implementation

- **Each DOT is allowed to set their own MASH implementation dates and their own MASH/NCHRP 350 implementation criteria.**
- **They may choose to establish their own deadline for MASH only compliance or they may permit NCHRP 350 compliant devices to be installed indefinitely.**
- **To date all states have are using NCHRP 350 compliant hardware as well as MASH devices. This is expected to continue to allow additional competition.**




CRASH ENERGY
IMPACT SEVERITY
Lateral Kinetic Energy (kJ)
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25º 50 km/h 2.3 t
25º 70 km/h 2 t
25º 70 km/h 2.3 t
25º 100 km/h 2 t
25º 100 km/h 2.3 t
15º 80 km/h 8 t
15º 90 km/h 10 t
15º 80 km/h 36 t
15º 80 km/h 36 t
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TL6
Containment Levels
NCHRP 350
MASH-1

INTERNATIONAL Effect

- By increasing the weight of the heavy vehicle, adding the midsize vehicle and increasing the redirect angle from 20 to 25 degrees, crash cushions tested to MASH will need to be stronger, and most likely more expensive. This will make these products less attractive to customers.

- As long as the States do not require MASH products and agree to allow the use of NCHRP 350 products, there will be little motivation for manufacturers to develop new products.

INTERNATIONAL Effect

- To increase competition, it is recommended that road authorities who are not required to use EN 1317 only, should continue to allow the use of NCHRP 350 products or EN 1317 products depending on the 85th percentile of their vehicle fleet.

- This complies with the resolution made by AFB20(2) and endorsed by the International Road Federation (IRF)

ROAD SAFETY HARDWARE RESOLUTION DATED JANUARY 14, 2008

The AFB20(2) Roadside Safety Design Subcommittee on International Research Activities recommends that road authorities in all countries should only specify roadside safety hardware, i.e. longitudinal safety barriers, crash cushions, terminals and transitions that has met either NCHRP 350 or EN 1317 criteria (or their updates)

INTERNATIONAL Effect

- To increase competition, it is recommended that road authorities who are not required to use EN 1317 only, should continue to allow the use of NCHRP 350 products or EN 1317 products depending on the 85th percentile of their vehicle fleet.

- This complies with the resolution made by AFB20(2) and endorsed by the International Road Federation (IRF)

- Regarding MASH, for now it would be better for international road authorities to consider "MASH" from the United States…


M*A*S*H

INTERNATIONAL Effect

- If international road authorities insist on using the MASH criteria, they should ask for one concession…
- Because the light weight vehicle in MASH is 1100 kg and it is likely that many lighter weight vehicles are present in the vehicle fleet in most countries, road authorities should also allow the use of MASH products, but request that the 820 kg vehicle test be run.

ANY QUESTIONS?

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1317 –

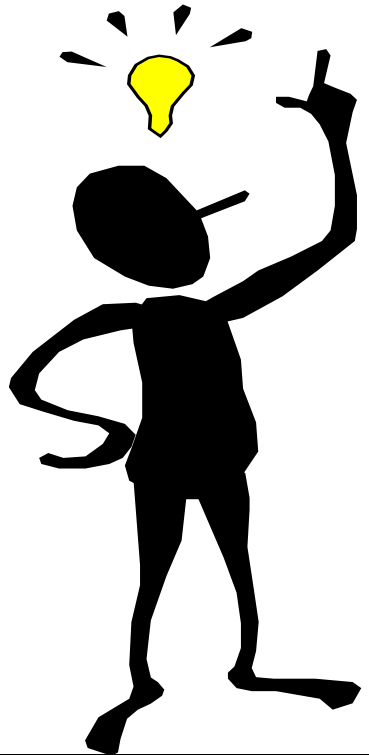
Road restraint systems

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

- ***Part 1: Terminology and general criteria for test methods***
- ***Part 2: Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets***
- ***Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions***
- ***Part 4: Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers (ENV)***
- ***Part 4: Performance classes, impact test acceptance criteria and test methods for transitions of safety barriers (under preparation)***
- ***Part 5: Road restraint systems - Part 5: Product requirements and evaluation of conformity for vehicle restraint systems***
- ***Part 6: Pedestrian restraint systems - Pedestrian Parapets (under preparation)***
- ***Part 7: Performance classes, impact test acceptance criteria and test methods for terminals of safety barriers (under preparation)***
- ***Part 8: Road restraint systems - Part 8 : Motorcycle road restraint systems which reduce the impact severity of motorcyclist collisions with safety barriers (under preparation)***

Understanding

EN 1317-2 & NCHRP 350/MASH



EVALUATION CRITERIA

NCHRP 350/MASH EVALUATION CRITERIA

- **STRUCTURAL ADEQUACY** - Defines acceptable test article behavior in terms of strength requirements.

Barrier Structural Adequacy

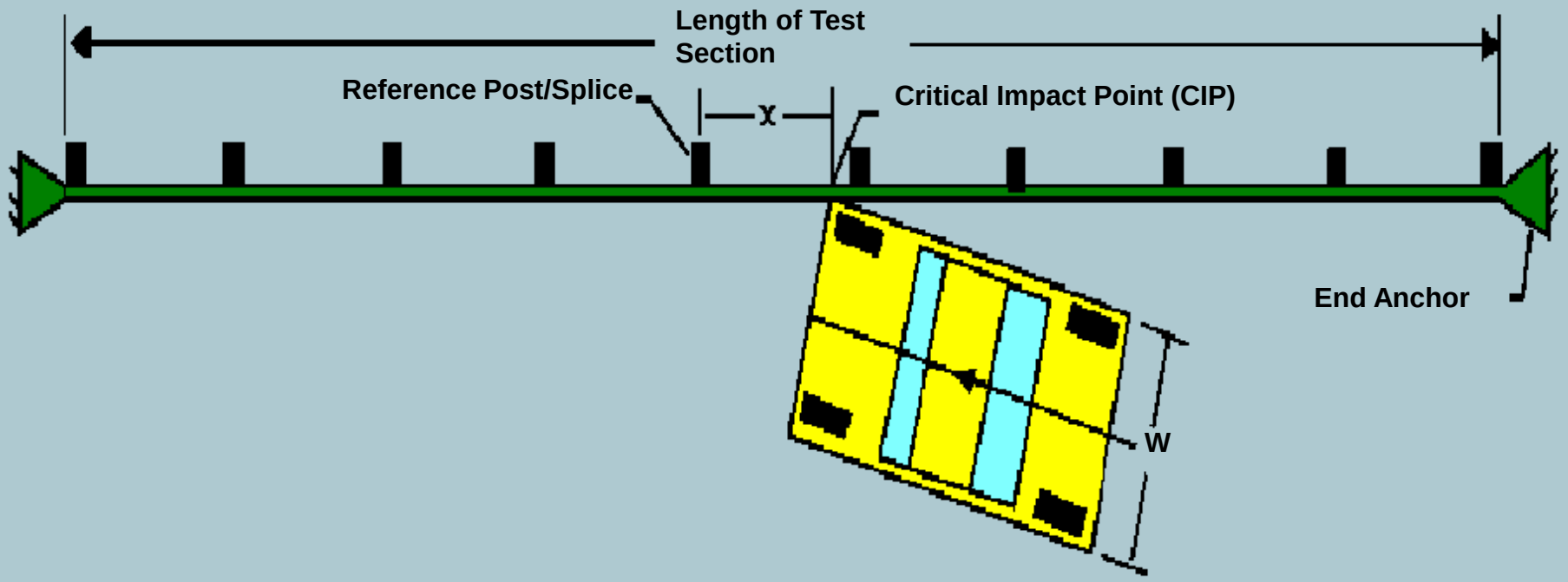
- *Test vehicle must be contained*
- *Test vehicle must be redirected or come to a controlled stop*
- *Controlled deflection of the barrier is acceptable*

NCHRP 350/MASH EVALUATION CRITERIA

- **STRUCTURAL ADEQUACY** - Defines acceptable test article behavior in terms of strength requirements.

EN 1317-2 EVALUATION CRITERIA

- **SAFETY BARRIER BEHAVIOR** - Defines acceptable test article behavior in terms of strength requirements and risks to vehicle's occupants.


Length of Test Section
Reference Post/Splice
X
Critical Impact Point (CIP)
End Anchor
W

Probably does not meet structural adequacy criteria

Probably does not meet structural adequacy criteria

Probably does not meet structural adequacy criteria

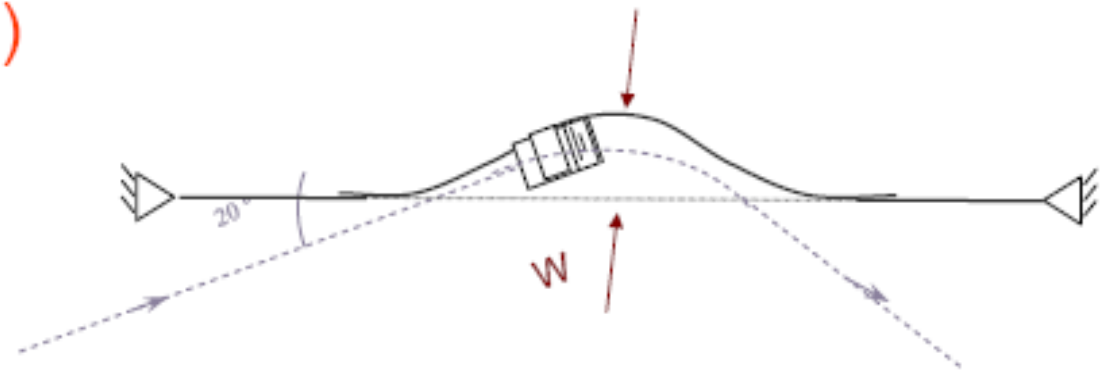
Probably does not meet structural adequacy criteria

STRUCTURAL ADEQUACY/SAFETY BARRIER BEHAVIOR

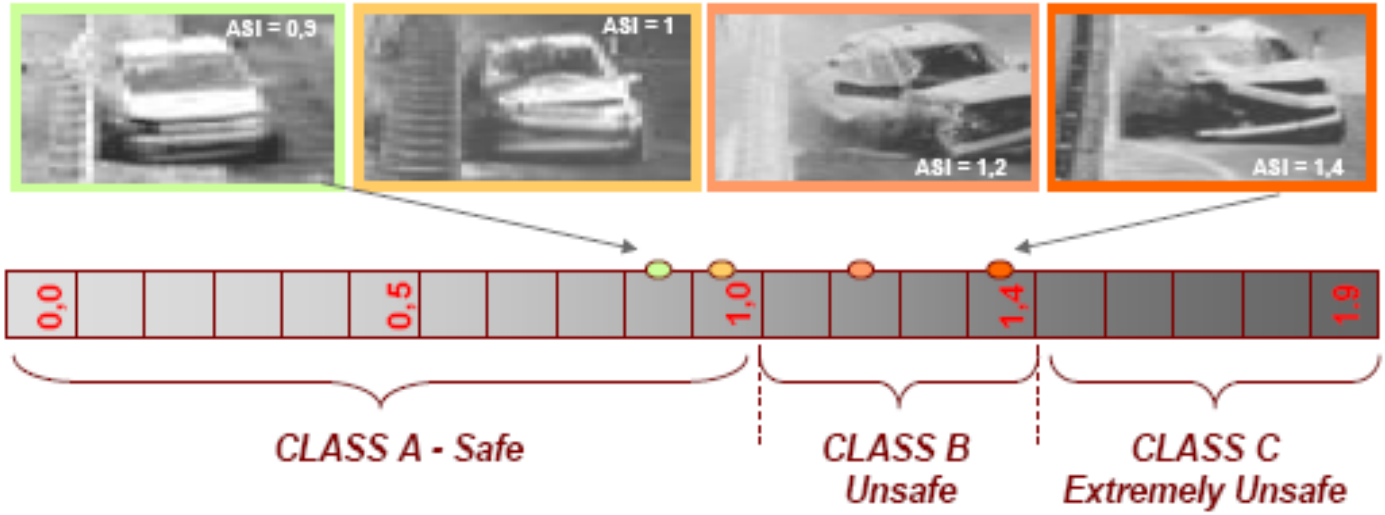
Evaluation Criteria

A.	Test article should contain and redirect the vehicle; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.
B.	The test article should readily activate in a predictable manner by breaking away, fracturing, or yielding.
C.	Acceptable test article performance may be by redirection, controlled penetration, or controlled stopping of the vehicle.

Working Width (W) & Impact Severity Index (ASI)



Working Width	W1	W2	W3	W4	W5	W6	W7	W8
Displacement less than [meters]	0.6	0.8	1.0	1.3	1.7	2.1	2.5	3.5
Displacement less than [feet]	2.0	2.6	3.3	4.3	5.6	6.9	8.2	11.5



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NCHRP 350
EVALUATION CRITERIA

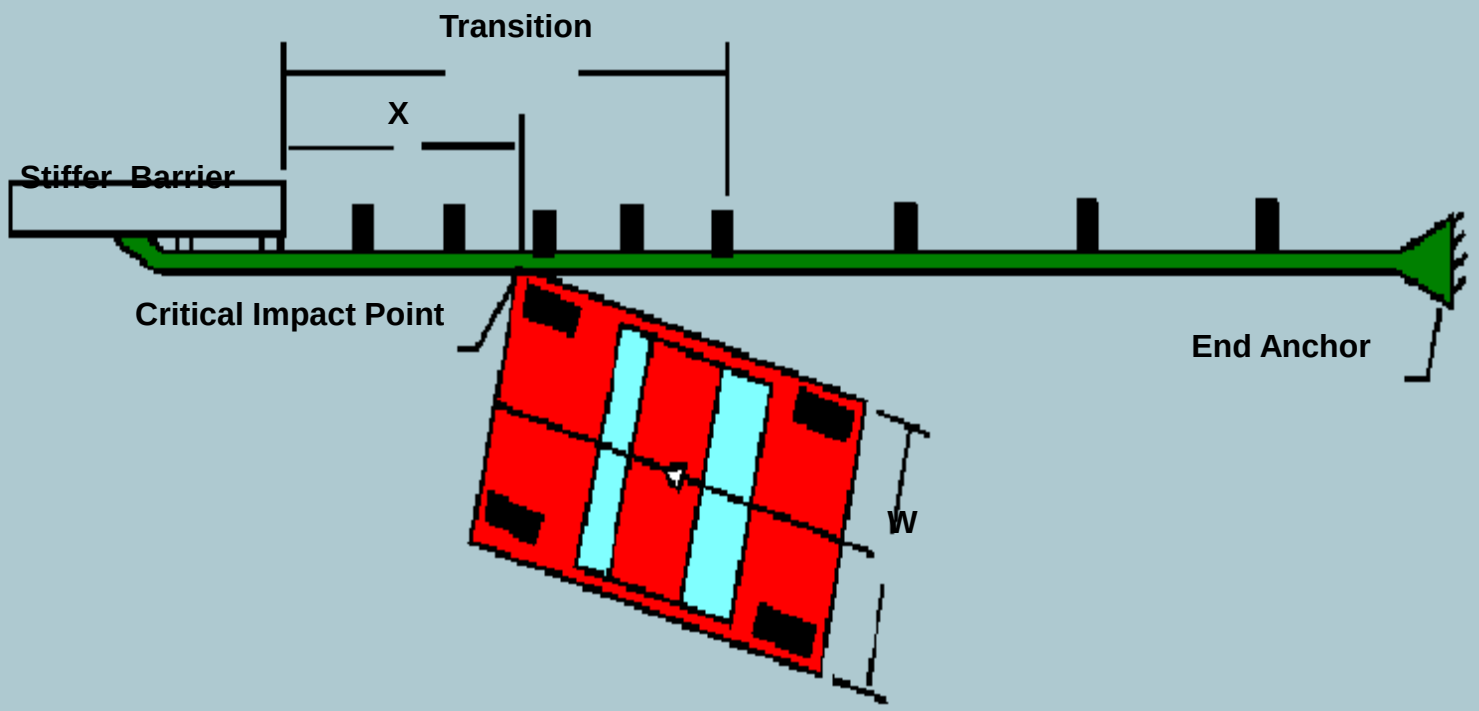
- **OCCUPANT RISK** - Defines acceptable test article behavior, vehicular behavior, and occupant risks parameters via the flail space model and ridedown “g”

NCHRP 350/MASH EVALUATION CRITERIA

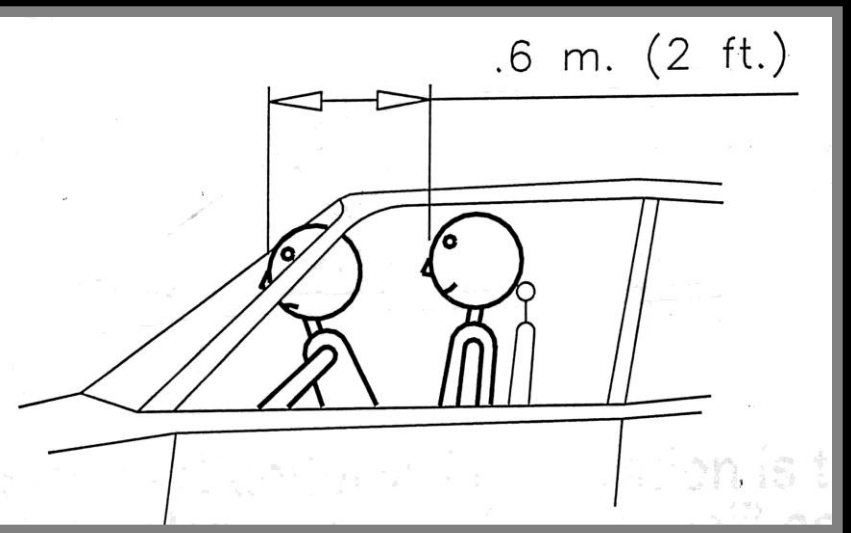
- **OCCUPANT RISK** - Defines acceptable test article behavior, vehicular behavior, and occupant risks parameters via the flail space model and ridedown “g”

EN 1317-2 EVALUATION CRITERIA

- **SEVERITY -** Defines acceptable occupant risk parameters via the THIV and ASI. (PHD GONE).

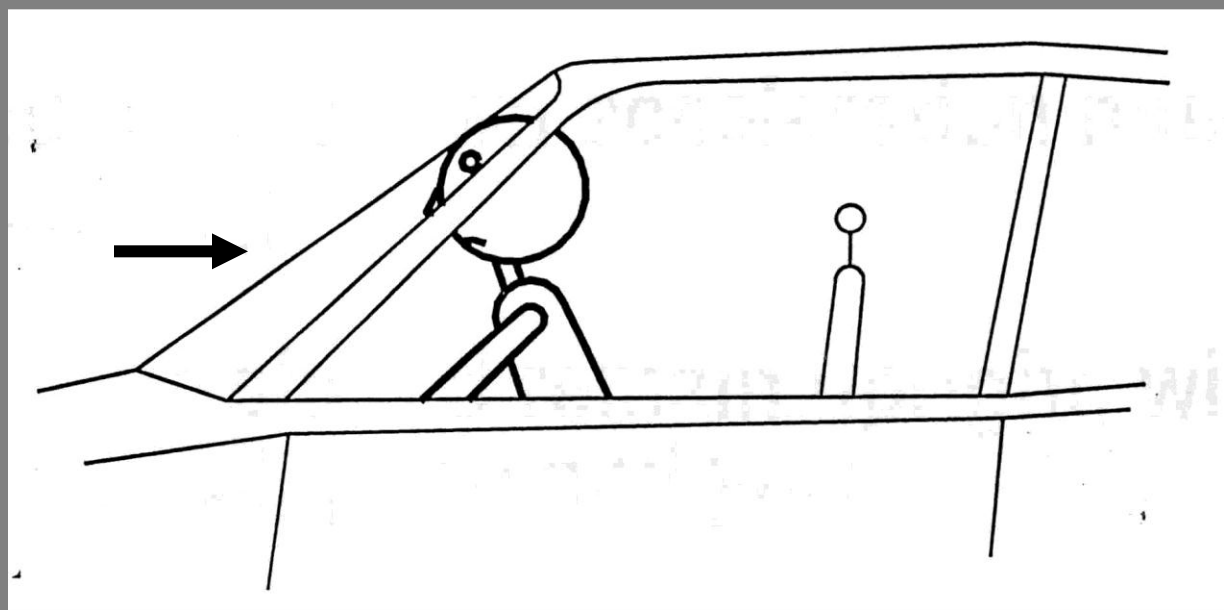

Transition
X
Stiffer Barrier
Critical Impact Point
End Anchor
W

OCCUPANT RISK/SEVERITY



- **Delta V/THIV**
  - Velocity of "theoretical" occupant impact with vehicle interior

- **Ridedown g/ASI**
  - Maximum vehicle and occupant g's



H. Occupant impact velocities (see Appendix A, Section A5.3 for calculation procedure) should satisfy the following:

Occupant Impact Velocity Limits (m/s)			
Component	Preferred	Maximum	
Longitudinal and Lateral	9	12	10, 20, 30, 31, 32, 33, 34, 36, 40, 41, 42, 43, 50, 51, 52, 53, 80, 81
Longitudinal	3	5	60, 61, 70, 71

I. Occupant ridedown accelerations (see Appendix A, Section A5.3 for calculation procedure) should satisfy the following:

Occupant Ridedown Acceleration Limits (G's)			
Component	Preferred	Maximum	
Longitudinal and Lateral	15	20	10, 20, 30, 31, 32, 33, 34, 36, 40, 41, 42, 43, 50, 51, 52, 53, 60, 61, 70, 71, 80, 81

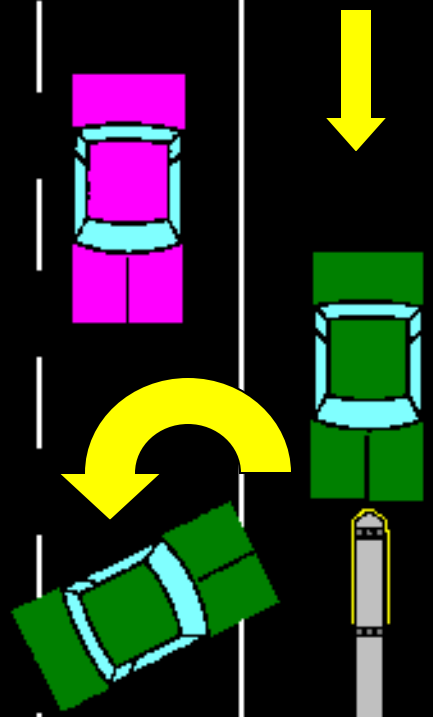
OCCUPANT RISK/SEVERITY

Evaluation Criteria	
D.	Detached elements, fragments or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone. Deformations of, or intrusions into, the occupant compartment that could cause serious injuries should not be permitted. See discussion in Section 5.3 and Appendix E.
E.	Detached elements, fragments or other debris from the test article, or vehicular damage should not block the driver's vision or otherwise cause the driver to lose control of the vehicle.
F.	The vehicle should remain upright during and after collision although moderate roll, pitching and yawing are acceptable.
G.	It is preferable, although not essential, that the vehicle remain upright during and after collision.

Impacts with concrete barriers can be violent...

100 km/h, 2000 kg, 25 degrees

Impacts with concrete barrier could cause intrusion



Intrusion could cause secondary or multiple accidents

However, these barriers do pass the test criteria.

However, these barriers do pass the test criteria.

A motorist would typically have less severe consequences hitting a flexible barrier than a rigid barrier


Frame -00000041

NCHRP 350
EVALUATION CRITERIA

- **VEHICLE TRAJECTORY** - Defines acceptable post-impact trajectory response of vehicle.

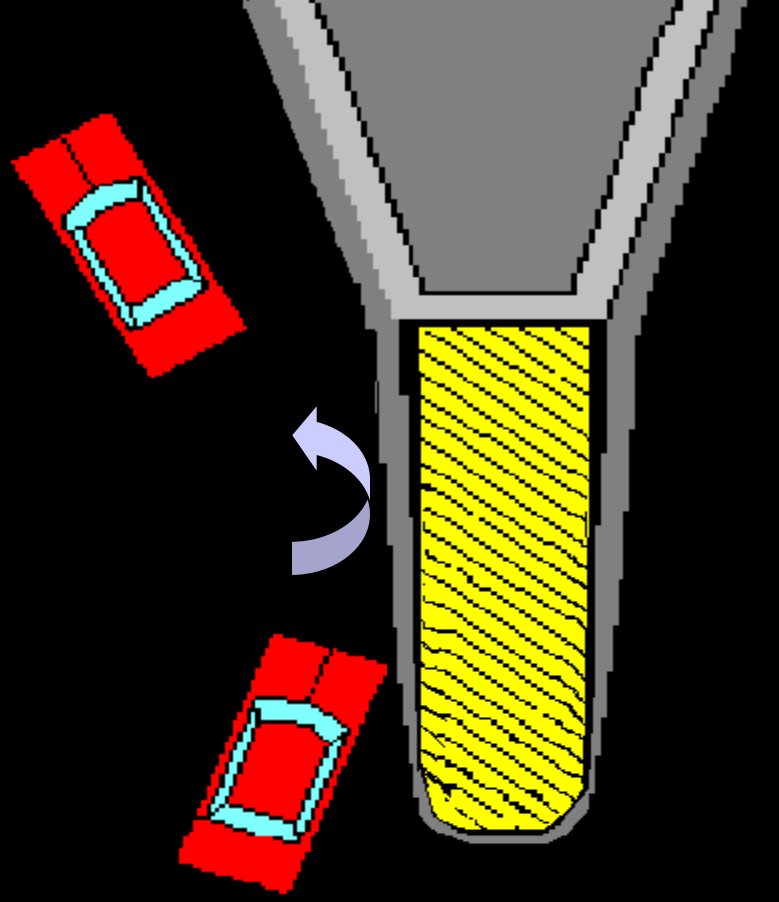
NCHRP 350/MASH EVALUATION CRITERIA

- **VEHICLE TRAJECTORY** - Defines acceptable post-impact trajectory response of vehicle.

EN 1317-2 EVALUATION CRITERIA

- **TEST VEHICLE BEHAVIOR** - Defines acceptable vehicular behavior during and after impact.


Vehicule mass: 1.500 Kg
Speed: 110 Km/h
Impact angle: 20°
Industrias Duero



Vehicle behavior after impact

VEHICLE TRAJECTORY/TEST VEHICLE BEHAVIOR

Evaluation Criteria

K.	After collision it is preferable that the vehicle's trajectory not intrude into adjacent traffic lanes.
L.	The occupant impact velocity in the longitudinal direction should not exceed 12 m/sec and the occupant ridedown acceleration in the longitudinal direction (see Appendix A, Section A5.3 for calculation procedure) should not exceed 20 G's.
M.	The exit angle from the test article preferably should be less than 60 percent of test impact angle, measured at time of vehicle loss of contact with test device.
N.	Vehicle trajectory behind the test article is acceptable.

NCHRP 350/MASH EVALUATION CRITERIA

- **STRUCTURAL ADEQUACY** - Defines acceptable test article behavior in terms of strength requirements.
- **OCCUPANT RISK** - Defines acceptable test article behavior, vehicular behavior, and occupant risks parameters via the flail space model.
- **VEHICLE TRAJECTORY** - Defines acceptable post-impact trajectory response of vehicle.

EN 1317-2
EVALUATION CRITERIA

- **SAFETY BARRIER BEHAVIOR -** Defines acceptable test article behavior in terms of strength requirements and risks to vehicle's occupants.
- **SEVERITY -** Defines acceptable occupant risk parameters via the THIV and ASI. (PHD GONE)
- **TEST VEHICLE BEHAVIOR -** Defines acceptable vehicular behavior during and after impact.

TEST LEVELS

NCHRP 350 CLASSIFICATIONS

TL-1	Test level for special, minimal service requirements	50 km/h
TL-2	Basic test levels for most service requirements	70 km/h
TL-3		100 km/h
TL-4	Test levels for special, higher service requirements	
TL-5		
TL-6		

General Guidelines

Test Level 1 is acceptable for some work zones and very low-volume, low-speed local streets and highways.

50 km/h

General Guidelines

Test Level 2 is acceptable for most local and collector roads and most work zones.

70 km/h

General Guidelines

Test Level 3 is acceptable for a wide range of high-speed roadways.

100 km/h

General Guidelines

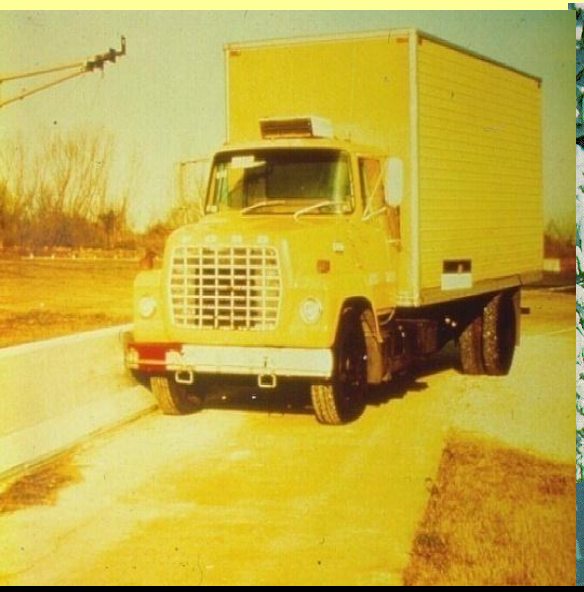
Test Levels 4-6 are applicable to highways with high volumes of truck traffic or to areas where penetration has serious consequences.

Test Levels 4-6

- *TL-3 Conditions plus*
- *Heavy vehicle at 80 kph*

Test Levels 4-6

TL-4 Vehicle:	TL-5 Vehicle:	TL-6 Vehicle:
8165 kg Single Unit Truck	36267 kg tractor-Trailer	36267 kg Bulk Fluid



Impact Conditions

Test Level	Barrier Section	Test Designation	Vehicle	Nominal Speed (km/h)	Nominal Angle, (deg)	*** Impact Point
1	Length of Need	1-10	820C	50	20	Midpoint
		S1-10*	700C	50	20	
		1-11	2000P	50	25	
	Transition	1-20**	820C	50	20	Transition
		S1-20*	700C	50	20	
		1-21	2000P	50	25	
2	Length of Need	2-10	820C	70	20	Midpoint
		S2-10*	700C	70	20	
		2-11	2000P	70	25	
	Transition	2-20**	820C	70	20	Transition
		S2-20*	700C	70	20	
		2-21	2000P	70	25	

NCHRP 350 Barrier Tests

* Test is optional

** Test may be optional

Impact Conditions

Test Level	Barrier Section	Test Designation	Vehicle	Nominal Speed (km/h)	Nominal Angle, (deg)	*** Impact Point
3	Length of Need	3-10	820C	100	20	Midpoint
		S3-10*	700C	100	20	
		3-11	2000P	100	25	
	Transition	3-20**	820C	100	20	Transition
		S3-20*	700C	100	20	
		3-21	2000P	100	25	
4	Length of Need	4-10	820C	100	20	Midpoint
		S4-10*	700C	100	20	
		4-11**	2000P	100	25	
	Transition	4-12	8000S	80	15	Transition
		4-20**	820C	100	20	
		S4-20*	700C	100	20	
		4-21**	2000P	100	25	
		4-22	8000S	80	15	

* Test is optional

** Test may be optional

NCHRP 350 Barrier Tests

Impact Conditions

Test Level	Barrier Section	Test Designation	Vehicle	Nominal Speed (km/h)	Nominal Angle, (deg)	*** Impact Point
5	Length of Need	5-10	820C	100	20	Midpoint
		S5-10*	700C	100	20	
		5-11**	2000P	100	25	
		5-12	36000V	80	15	
	Transition	5-20**	820C	100	20	Transition
		S5-20*	700C	100	20	
		5-21**	2000P	100	25	
		5-22	36000V	80	15	
6	Length of Need	6-10	820C	100	20	Midpoint
		S6-10*	700C	100	20	
		6-11**	2000P	100	25	
		6-12	36000V	80	15	
	Transition	6-20**	820C	100	20	Transition
		S6-20*	700C	100	20	
		6-21**	2000P	100	25	
		6-22	36000V	80	15	

* Test is optional

** Test may be optional

EN 1317-2 CLASSIFICATIONS

T1	Containment for temporary use only
T2	Containment for temporary use only
T3	Containment for temporary use only
N1	Normal Containment
N2	Normal Containment
H1	Higher Containment
H2	Higher Containment
H3	Higher Containment
H4a	Very High Containment
H4b	Very High Containment

EN 1317-2 VELOCITIES

Typical Test speeds are
80 km/h, 100 km/h & 110 km/h

T-1, T-2, T-3 Temporary Barrier Only

T-1, T-2, T-3 Temporary Barrier Only

N-1 and N-2 acceptable for most roads

H-1, H-2 and H-3

higher containment for roads with heavy truck use and/or high speeds

H-4a, H-4b

Very high containment for areas where penetration has serious consequences

TEST MATRIX FOR HIGH CONTAINMENT

High containment levels	Acceptance test
Higher containment	
H1	TB 42 and TB 11
H2	TB 51 and TB 11
H3	TB 61 and TB 11
Very high containment	
H4a	TB 71 and TB 11
H4b	TB 81 and TB 11

VEHICLES

NCHRP 350 VELOCITIES

Vehicle Type	Mass (KG)	Primary Function
USA		
Small Car	820	Occupant Risk
Pickup Truck	2000	Structural Adequacy

NCHRP 350 Test Vehicle Types

820C small car

2000P pickup truck

Test vehicles represent 85th percentile of passenger vehicles

NCHRP 350Test Vehicle Types

820C small car

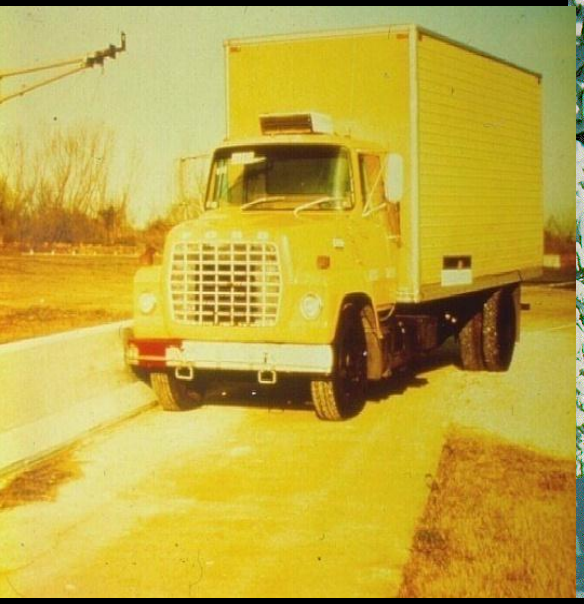
2000P pickup truck

8000S, 36000V and
36000T heavy truck

NCHRP 350/MASH Test Levels 4-6

TL-4 Vehicle:

8165 kg
Single Unit Truck



TL-5 Vehicle:

36267 kg
Tractor-Trailer

TL-6 Vehicle:

36267 kg
Bulk Fluid

TEST VEHICLES

Vehicle Type	Mass (KG)	Primary Function
USA		
Small Car	820	Occupant Risk
Pickup Truck	2000	Structural Adequacy
EN 1317		
Small Car	900	Occupant Risk
Mid-Size Car	1300	Occupant Risk and Structural Adequacy
Full-Size Car	1500	Occupant Risk and Structural Adequacy

EN 1317-2 Test Vehicle Types

900 kg vehicles

1.300 kg vehicles

1.500 kg vehicles

EN 1317-2 Test Vehicle Types

16,000 kg vehicles

38,000 kg vehicles

70 km/h, 13000 kg, 20 degrees

Test vehicle type & mass

NCHRP 350

Auto 820 or 700 kg

Pick up / SUV
2.000 kg

Rigid Truck
8000 kg

Articulated Truck
36.000 kg

Articulated Tanker
36.000 kg

EN 1317

Auto 900,
1.300 and 1.500 kg

Rigid Truck
10.000 kg

Bus
13.000 kg

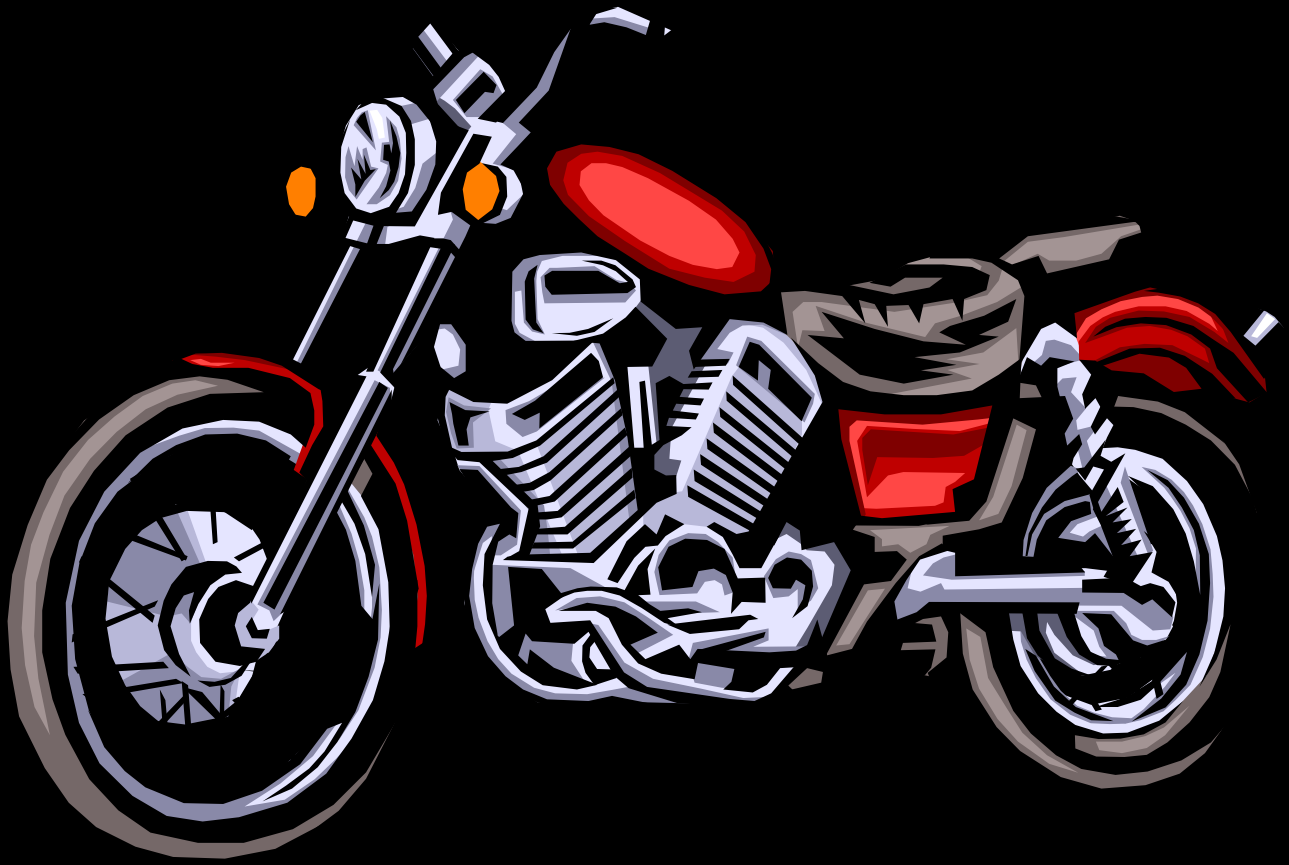
Rigid Truck
16.000 kg

Rigid Truck
Double steering axle
30.000 kg

Articulated Truck
38.000 kg

Test Vehicle Types

What about motorcycles!?



Neither NCHRP350 nor EN 1317-2 test with motorcycles

RIDING A MOTORCYCLE CAN BE DANGEROUS

RIDING A MOTORCYCLE CAN BE VERY DANGEROUS

LONGITUDINAL BARRIERS PRESENT A SPECIAL PROBLEM

BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

In 2005, approximately 1 in 10 motorcyclists striking a guardrail were killed.

This is a fatality risk over 80 times higher than a passenger vehicle occupant.

Source: Hampton C. Gabler. Emerging Risk of Fatal Motorcycle Crashes with Guardrails. Virginia Tech Center for Injury Biomechanics.

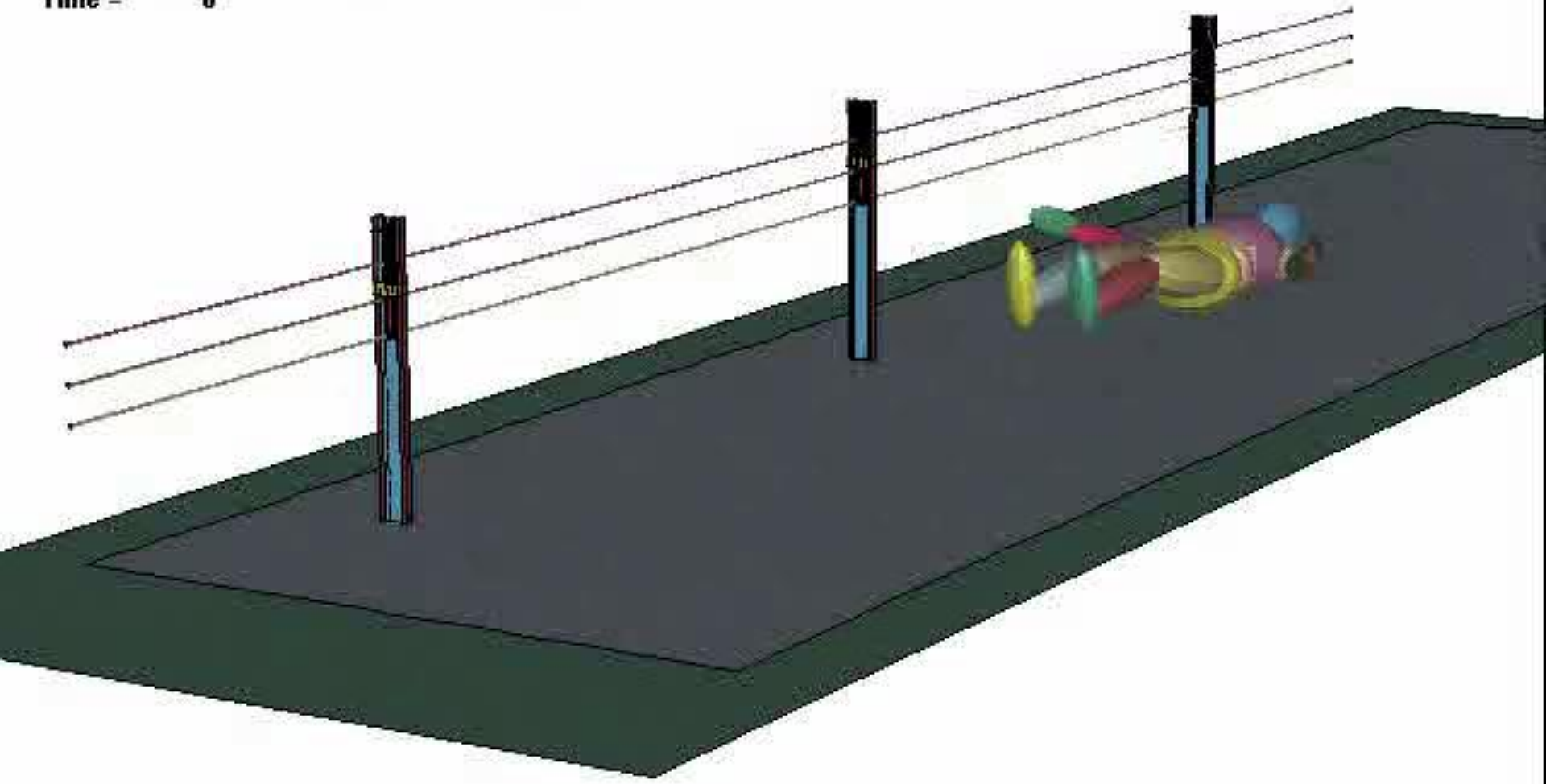
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

Those who survive a guardrail impact may still be seriously injured.


SH99.05

DUMMY TEST – 80 KM/H – 20 DEGREES

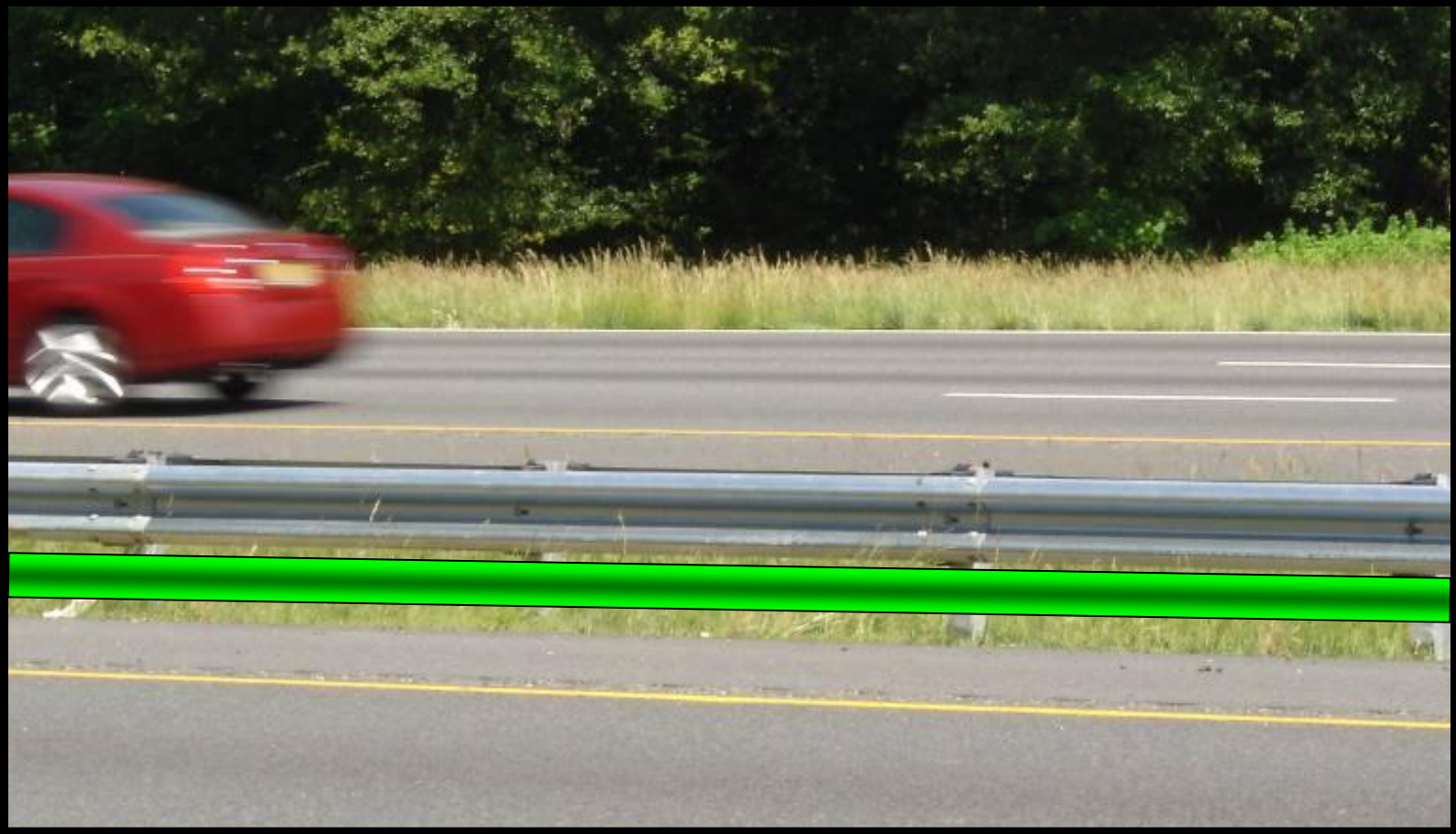
Time = 0



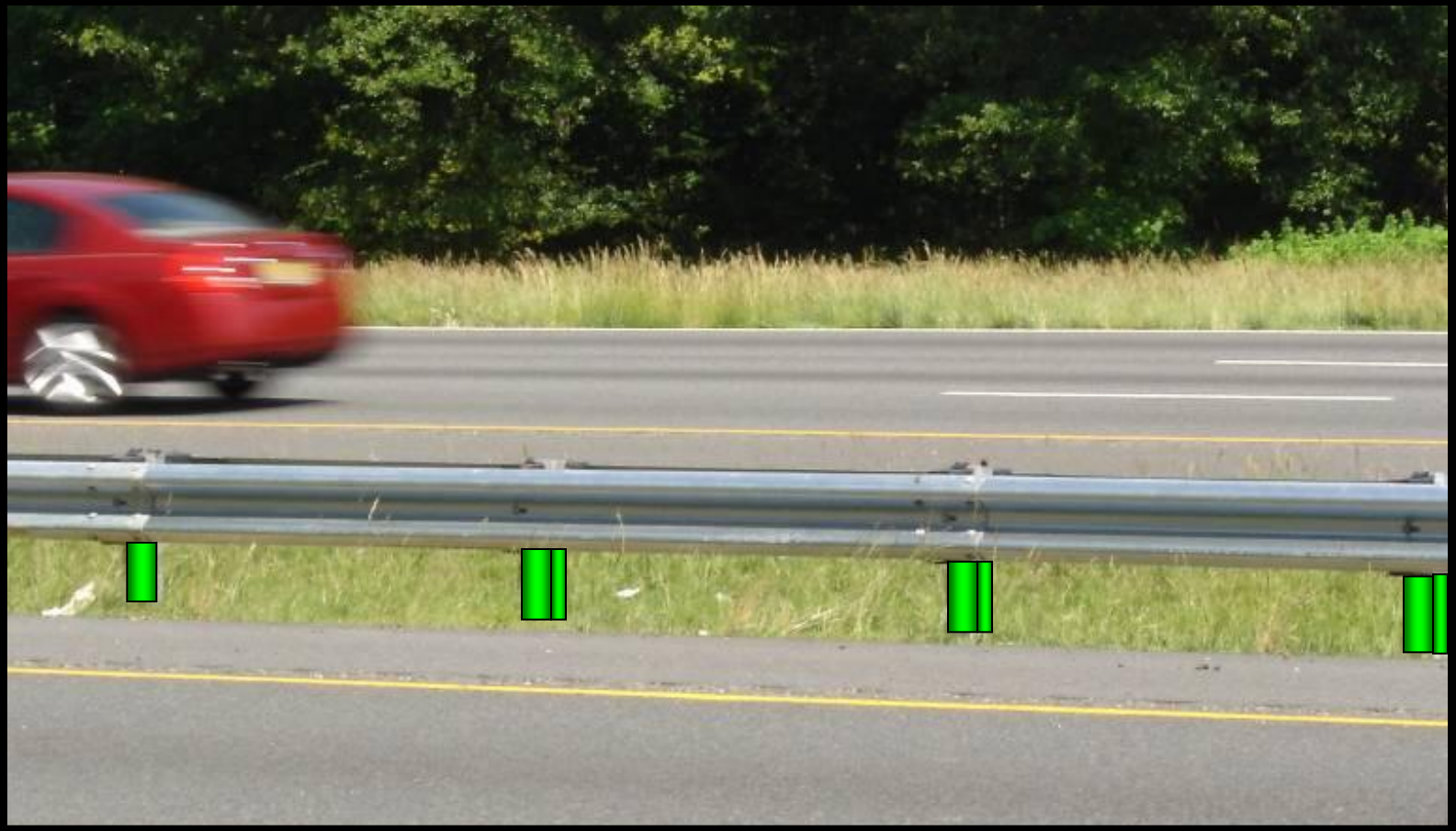
CorrOcean

EN 1317 will be adding voluntary motorcycle safety considerations to their criteria

Countermeasure Option 1: Lower W-Beam



Countermeasure Option 2: Energy Absorbing Post Coverings



ANY QUESTIONS?

NCHRP 350/MASH or EN-1317-2 Tests Must Be Conducted With A Minimum Specified Impact Severity Level

The Combination of

Vehicle mass

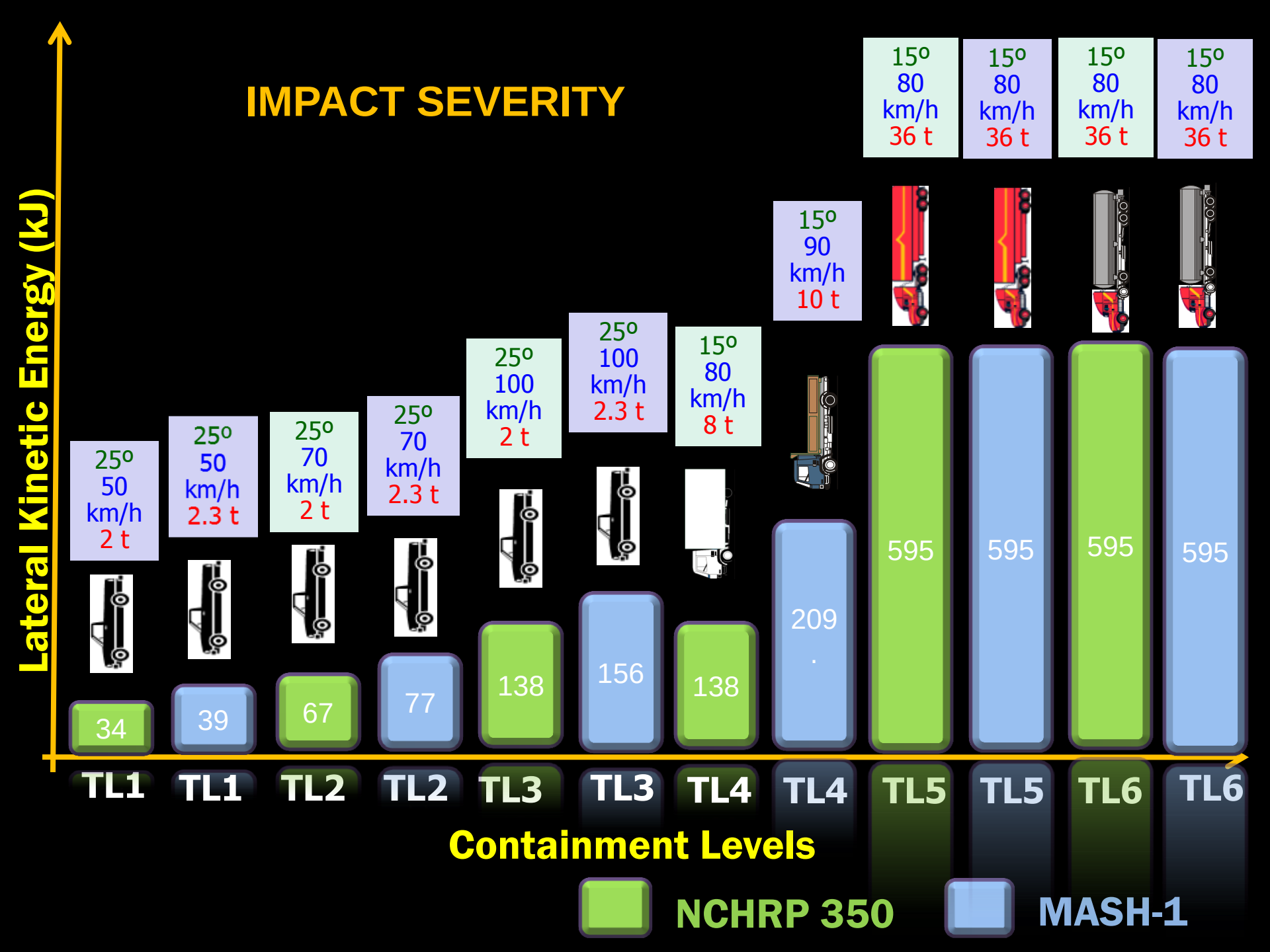
Vehicle speed

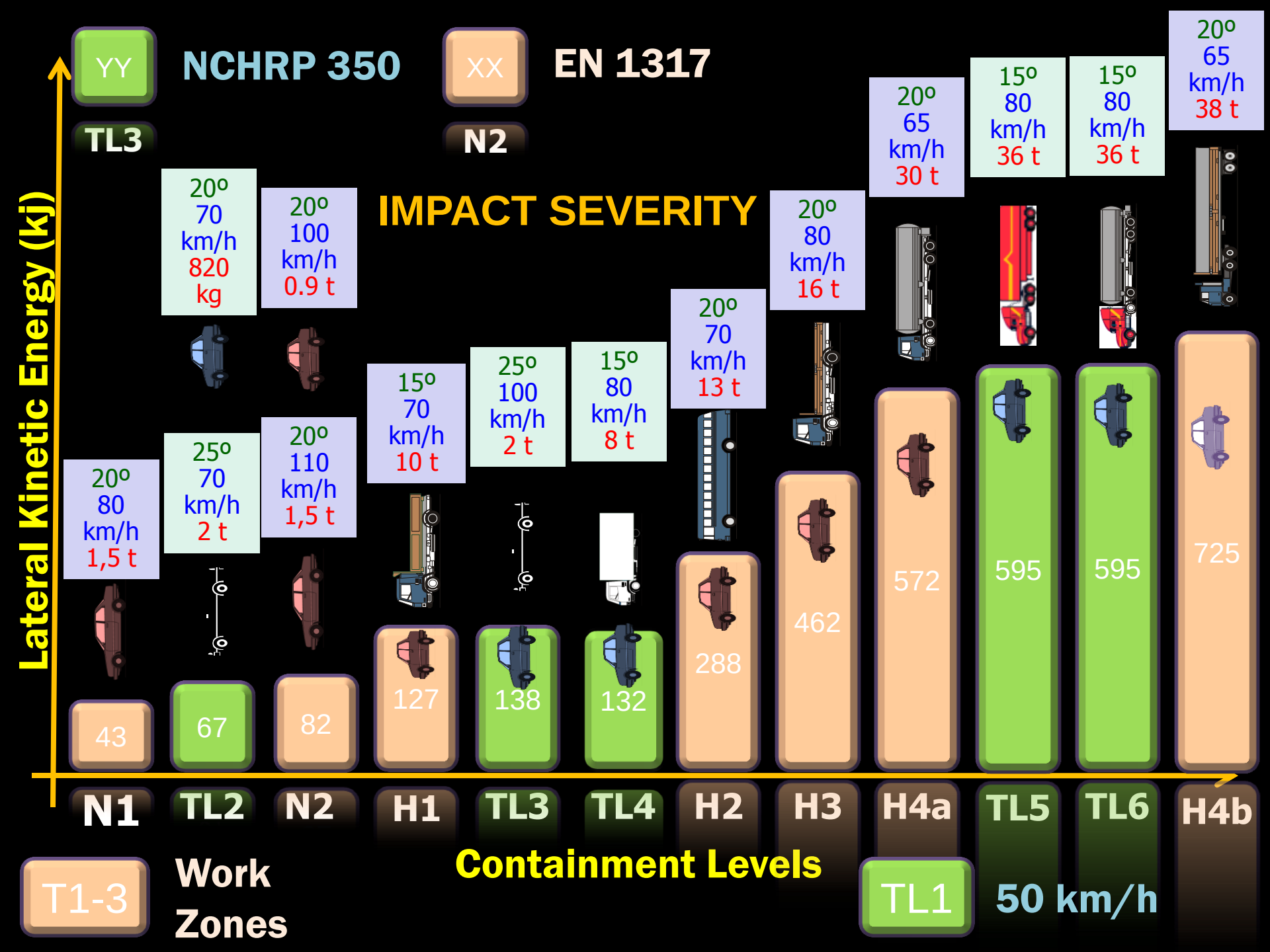
Impact angle

Impact Severity

The measurement of the amount of force generated during an impact in kilojoules (kJ).

NCHRP 350/MASH or EN-1317-2 Tests Must Be Conducted With A Minimum Specified Impact Severity Level


IMPACT SEVERITY
Lateral Kinetic Energy (kJ)
25º 50 km/h 2 t
25º 50 km/h 2.3 t
25º 70 km/h 2 t
25º 70 km/h 2.3 t
25º 100 km/h 2 t
25º 100 km/h 2.3 t
15º 80 km/h 8 t
15º 90 km/h 10 t
15º 80 km/h 36 t
15º 80 km/h 36 t
15º 80 km/h 36 t
15º 80 km/h 36 t
34
39
67
77
138
156
138
209
595
595
595
595
TL1
TL1
TL2
TL2
TL3
TL3
TL4
TL4
TL5
TL5
TL6
TL6
Containment Levels
NCHRP 350
MASH-1


YY
NCHRP 350
XX
EN 1317
TL3
N2
IMPACT SEVERITY
Lateral Kinetic Energy (kj)
20º 80 km/h 1,5 t
25º 70 km/h 2 t
20º 70 km/h 820 kg
20º 110 km/h 1,5 t
20º 100 km/h 0.9 t
15º 70 km/h 10 t
25º 100 km/h 2 t
15º 80 km/h 8 t
20º 70 km/h 13 t
20º 80 km/h 16 t
20º 65 km/h 30 t
15º 80 km/h 36 t
15º 80 km/h 36 t
20º 65 km/h 38 t
43
67
82
127
138
132
288
462
572
595
595
725
N1
TL2
N2
H1
TL3
TL4
H2
H3
H4a
TL5
TL6
H4b
Containment Levels
T1-3
Work Zones
TL1
50 km/h

ANY QUESTIONS?

Which Criteria Should We Use?

Which Criteria Should We Use?

The IRF endorses the following proclamation that was unanimously approved at TRB in January 2008:

Which Criteria Should We Use?

- *The AFB20(2) Subcommittee recommends that road authorities in all countries should only specify roadside safety hardware, i.e. longitudinal safety barriers, crash cushions, terminals and transitions that has met either NCHRP 350 or EN 1317 criteria (or their updates) -*

Which Criteria Should We Use?

Both criteria are good.

Which Criteria Should We Use?

Both criteria are good.

Understand the differences to decide which are best for you

Which Criteria Should We Use?

Both criteria are good.

Understand the differences to decide which are best for you

It may be most economically feasible to allow both criteria to be used (more competition)

Which Criteria Should We Use?

The NCHRP 350/MASH and EN 1317 test standards were developed considering the vehicles in use regionally, that is, USA and Canada or Europe

Which Criteria Should We Use?

Each country choosing a test criteria should consider the mass and elevation of the center of mass of vehicles that are commonly used within the country. This may be critical when considering barrier terminals and crash cushions .

ANY QUESTIONS?

IRF SAFER ROADS BY DESIGN®




expo 2012 vial Argentina

XVI ARGENTINE CONGRESS OF ROAD ADMINISTRATION AND TRAFFIC

7° EXPOVIAL ARGENTINA

OCTOBER 22nd to 26th, 2012

IX INTERNATIONAL CONGRESS OF ITS

XXXVII ASPHALT MEETING

INTERNATIONAL SEMINAR ON CONCRETE PAVEMENT

XXXVII REUNIÓN DEL ASFALTO

ICPA

COMPLEJO FERIAL CÓRDOBA - CITY OF CÓRDOBA- ARGENTINA

TRANSPORT CHALLENGES FACING GROWTH