UPDATE OF THE U.S. CRASH TEST PROCEDURES


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How good was 350?

- 2000 P Pickup was questioned – crash tests run on comparable vehicles:
  - 2000 P
  - Geo Tracker
  - Ford Explorer
  - Standard van
  - Tests at 20 degrees, 100 kmh
Reasons To Update Report 350

- Reconsider assumptions that underlie 350.
  - Technological advances that have occurred.
  - Changes in specifications
  - Reflect changes in vehicle fleet
Time to update Report 350

- Issues reviewed for updating:
  - Test vehicles
  - Impact conditions
  - Critical Impact Points
  - Efficacy of Flail Space Model
  - Soil type and conditions
  - Test documentation
  - Working width measurement
Time to update Report 350

- Relevance of performance evaluation procedures not fully understood
- There has been little assessment of the effect of upgrading hardware
- Have been technological advances in the last 10 years
- Changes to other specifications
Time to update Report 350

- How do we consider the effect of seat belts and air bags?
- What angles do vehicles leave the roadway?
- How do we account for propensity for rollovers?
- How do barriers perform in the field?
NCHRP Project 22-14

“Improvement of the Procedures for the Safety Performance Evaluation of Roadside Features”

King Mak, Roger Bligh, Lindsay Griffin of Texas Transportation Institute

Final Report June 2001
NCHRP Project 22-14

Objectives:
- Evaluate the relevance and efficacy of procedures for the safety performance evaluation of highway features
- Assess the needs for updates to NCHRP Report 350 and recommend strategies for implementing them
I. Relevance

Are the selected test conditions based on real-world impact conditions?

Will a proposed change in the test guidelines result in a reduction in the severity of crashes?
I. Relevance

Major research needed for relevancy:
- Distribution of impact conditions
- In-service performance of roadside hardware
- Performance limits of roadside hardware
- Relationship of injury severity to impact conditions
- Relationship of injury severity to crash test evaluation criteria
II. Assessment of Updating Needs

Potential updates:
- Test vehicles and specifications
- Impact conditions
- Critical Impact Point
- Efficacy of flail space model
- Soil type and condition
- Test documentation
- Working width measurement
Potential Updates

- Test Vehicles and Specifications
  - 2000P ?
  - 820C ?
  - New intermediate vehicle?
  - Should specs include additional properties?
  - Heavy trucks?
Test Vehicles and Specs

- 2000 kilogram pickup truck
- Crash analysis shows pickups and SUVs are worst among “light trucks” for crash frequency, severity, and rollovers.
- 2000P (3/4 ton pickup) was shown to be the least stable of the light trucks tested and is a good “surrogate” for this class
- Extended cab pickup may be the most common type of PU sold - this will need to be considered.
Test Vehicles and Specs

- 820 kg passenger car to be replaced as standard - likely retained as optional
- Geo Metro for 2000 was last car produced in this size range.
- Small car likely to be 1000+ kg sedan
- Terminal and barrier tests would benefit
- Breakaway tests likely would have reduced speed.
Test Vehicles and Specs

Intermediate test vehicle
- Would be more representative of vehicle fleet, but not more critical
- 1500 kg car would match CEN standards
- Not recommended as a standard vehicle for all devices.
- Consider for staged energy absorbing devices such as some crash cushions or TMA’s. New panel to decide.
Test Vehicles and Specs

- Heavy Trucks
- Minor changes in how TL-4, TL-5, and TL-6 heavy vehicles are specified are expected.
- Changes will have no effect on hardware already tested
- Comment - May consider allowing a sleeper cab
Impact Conditions

- Impact speed – Increase to 110 kmh?
- Impact angles – 25 degrees too sharp?
- Impact angles – 90 degrees for omni-directional breakaway features?
- TMA test – Should shadow truck be braced?
Impact Conditions

- Consider raising impact speed from 100 to 110 kmh - would cover an additional 2.84% of crashes.
  - Would mean minor changes to some hardware, complete replacement of others
  - We do not know enough to be able to perform an accurate cost-benefit analysis
  - Recommend: Top speed to remain at 100 kmh

- TL-2 speed is 70 km/h (43.5 mph) while the CEN standard specifies 80 km/h (50 mph)
  Consider harmonizing.
Impact Conditions

- Impact Angle of 25 degrees into CIP
- Tests with 2000P into barriers has shown problems with stability of the test vehicle
- Three circumstances considered:
  - Barrier length of need
  - Transition from Guardrail to Bridgerail
  - Temporary work zone barrier
Impact Conditions

- 25 Degree impact into barrier length of need
  - Not an impossible scenario
  - Some longitudinal barriers are placed a great distance from the roadway
  - Sufficient alternatives available that have already passed TL-3 using 25 degrees
  - Recommend: do not change
Impact Conditions

- Change 25 Degree impact into approach transition from guardrail to bridgerail to 20 degrees
  - Very rare situation for impact at CIP
  - Transitions usually placed near the roadway.
  - Researcher recommend: Change immediately to 20 degree impact into Critical Impact Point
  - Some panel members say keep 25 degrees.

- Likely to stay at 25 degrees.
Impact Conditions

- Change 25 Degree impact into temporary concrete barriers to 20 degrees
  - Rare situation for impact at high angle
  - Temporary barriers often placed near the roadway, sometimes on both sides
  - Some designs have passed TL-3 at 25 degrees
  - Researchers recommend: Change to 20 degree impact into temporary barriers
  - Panel likely to keep at 25 degrees
Impact Conditions

- Small Car impact into Truck Mounted Attenuator
  - Truck to be braced to eliminate variables
  - Good arguments for keeping brace or for removing.
  - Researchers recommend removing the artificial constraint of the brace
  - New study will likely conduct a survey
Impact Conditions

- Truck Mounted Attenuators
  - Comment
  - Optional angle impacts may be required.
Impact Conditions

- Omni Directional Breakaway Supports
- It is logical to test omni-directional supports at 0 degrees and 90 degrees
- Recommend increasing upper limit of impact angle from 20 to 90 degrees for omni-directional breakaway supports
Critical Impact Points for Transitions and Terminals

- Test outcome is very sensitive to impact point
- Simulations were run to find the most sensitive location for testing barriers
- New CIPs for transitions were found
- Recommend that work continue on defining methods to establish CIP for each device
Efficacy of Flail Space Model

Should the current risk criteria be revised to take into account the various safety features built in the current generation of passenger cars.
- Airbags are standard equipment.
- Seat belt use is at 70 percent.
- No national primary seat belt law or laws

Should the flail space model be abandoned altogether in favor of some form of occupant simulation model to allow for more realistic assessment of occupant response and risk of injury?
Flail Space Model

- Researcher recommend: Keep the flail space model using the theoretical unrestrained occupant.
- Calculate using the CEN method. Use resultant of the theoretical occupant velocity at time of impact instead of the component.
  - Theoretical head Impact Velocity (THIV)
  - Post-Impact Head Deceleration (PHD)
Instrumented Crash Test Dummies

- Actual forces and accelerations on occupants can be measured with a dummy
- Repeatability is very sensitive to position of dummy at impact – may require seat belts
- Vehicle interior can have a significant impact on dummy response
- Dummies would have to be modified for oblique impacts
- Researchers recommendation - Dummies not yet practical for safety hardware testing
Advances in biomechanics and computer modeling have made occupant models much more accurate.

Articulated Total Body Model (ATB) was developed from research at CALSPAN and Wright-Patterson Air Force Base.

Must also model vehicle interior surfaces.
Crash Victim Simulators

- Mathematical Dynamic Model (MADYMO)
- LS-DYNA Finite Element Program
- None are yet practical for use in simulating occupants in hardware crashes
- Likely to add LS-DYNA to the update
Soil Type and Condition

- NCHRP Report 350 has “Standard Soil” and “Weak Soil”
- Use of Weak Soil limited to certain breakaway supports
- Soils meeting the sieve specifications may still vary widely in strength
Soil Type and Condition

Recommendation:
- Keep Strong and Weak soil specifications
- Test soils used by each test agency
- Establish acceptable range of soil strength
- Add performance-based specification to 350 update that will require static testing of soil strength for each crash test and determination of moisture content.
Test Documentation

- Some test reports lack:
  - Adequate description of test article and how it was constructed
  - Information on the components used in construction of the test article
  - Details of soil type and condition

- Some test articles do not match drawings
Test Documentation

Recommend:
- Include CAD drawing of test article
- Report significant deviations or variations from drawings
- Report any unusual items pertaining to installation that could affect performance
- Report actual dimensions of critical parts
- Include FHWA requirements

Greater detailed on existing 350 requirements
Test Documentation

- Other potential refinements:
  - Assessment of windshield damage - FHWA proposal
  - Assessment of occupant compartment deformation
  - Report should assess pass or fail criteria
  - Harmonize format with CEN standards
  - Other measures to assess repeatability
Working Width Measurement

- Similar to “dynamic deflection”
- Working Width Measurement: Distance between the side facing the traffic before impact of the test barrier and the maximum dynamic lateral position of any major part of the barrier or the vehicle.
- Recommended to be added
Other Addition

- Side impact will probably be added as an option.
Future Actions

- NCHRP 22-14 Final Report was issued to the panel in June.
- New panel will have its first meeting in August.
- Contract will probably be underway by January 2002 to update Report 350.
Future Actions

- AASHTO will then evaluate the study. Perform crash tests to evaluate changes if needed. Then will adopt by ballot of all State DOT’s.
- FHWA will adopt as a requirement for the National highway system.
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