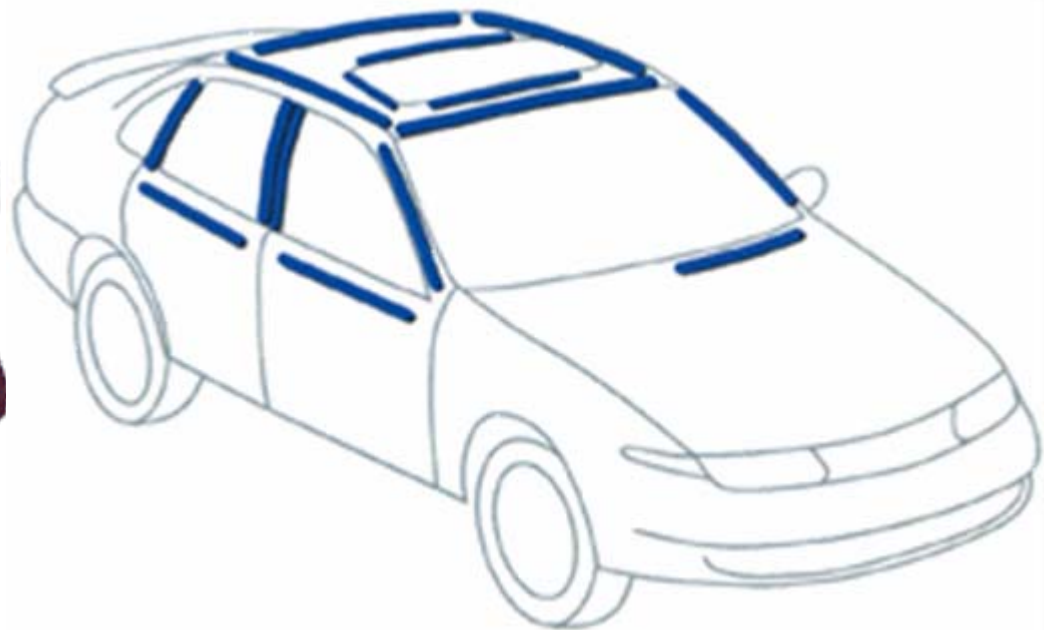
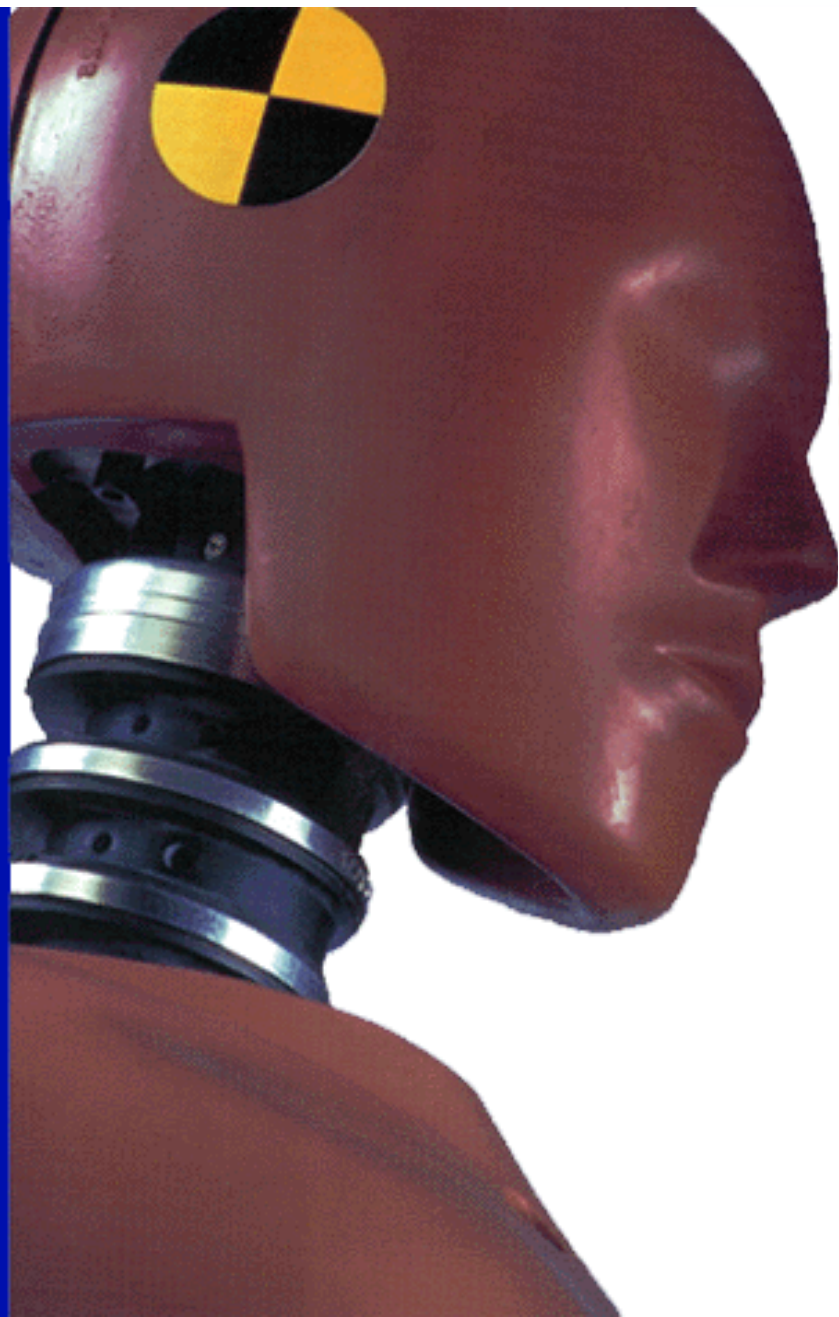


O-FLEX *AUTOMOTIVE*



O-EA™

ENERGY ABSORBING TUBING

O-EA[™] Energy Absorbing Tube APPLICATIONS

- Head Impact
 - Pillar trim
 - Side rail and roof lining
 - Side curtain airbag attachment
- Side Impact
 - Upper arm & thoracic protection
 - Pelvis and leg protection
- Pedestrian Protection
 - Soft bumpers
 - Under hood attachment

Tube Sections



- Squares 14 to 55mm
- Rectangles 10 to 80mm 1:2 ratio limit
- Round sections 18 to 100mm OD
- Irregular shapes for contour fit

O-EA™ Tubes – Head Impact

The O-Flex O-EA™ tube products help our customers meet and or exceed Federal regulations as outlined in FVMSS 201.

O-Flex Energy Absorbing Tubes provide one of the most cost effective and efficient measures to reduce HIC in any location in the upper interior. Occupant protection is a critical area of automotive engineering that requires efficient use of space without impairing performance.

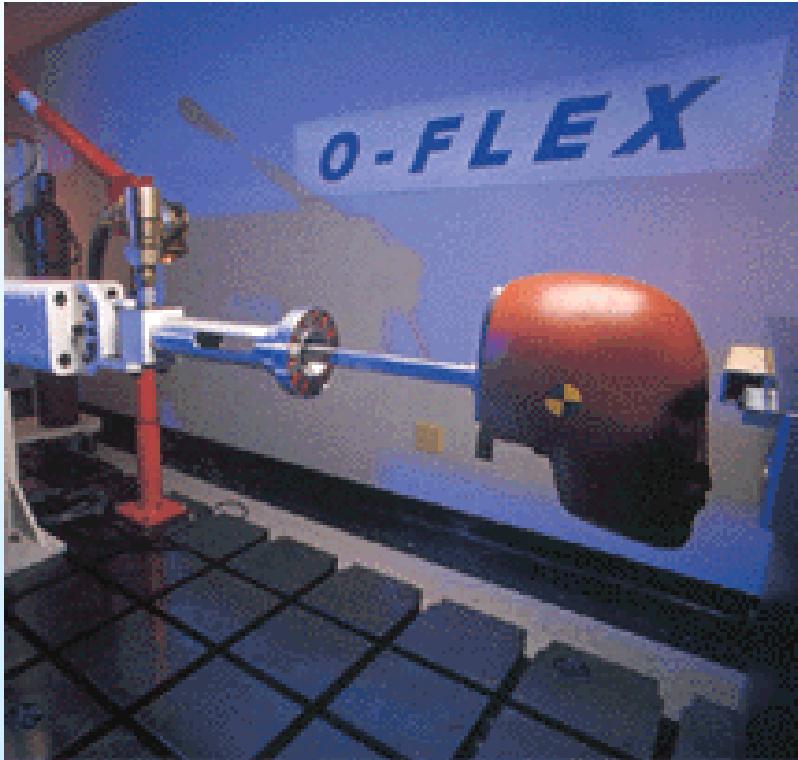
Within the limited space and peak forces required, O-EA Tube performance is unsurpassed by most other countermeasures. For difficult HIC requirements, O-EA tubes can offer a variety of shapes and loads to help achieve HICd levels below the accepted 800 level used by most OEM's. Load strengths can be matched to an application to provide the maximum energy absorption possible for the limited space available.

O-Flex cost effectiveness versus performance is premium for crush spaces between 10 and 25mm.

The application areas in the vehicle utilizing “head Impact” construction are:

- Side Rail & Roof Region
- Sunroof area
- A, B, & C pillar areas

Head Impact Test



- Highly efficient in space per energy absorbed
- Application specific tuning to optimize HIC_d result.
- Load ranges from 1.0 to 8.0 kN using FMH Hybrid III Headform
- Temperature resistant

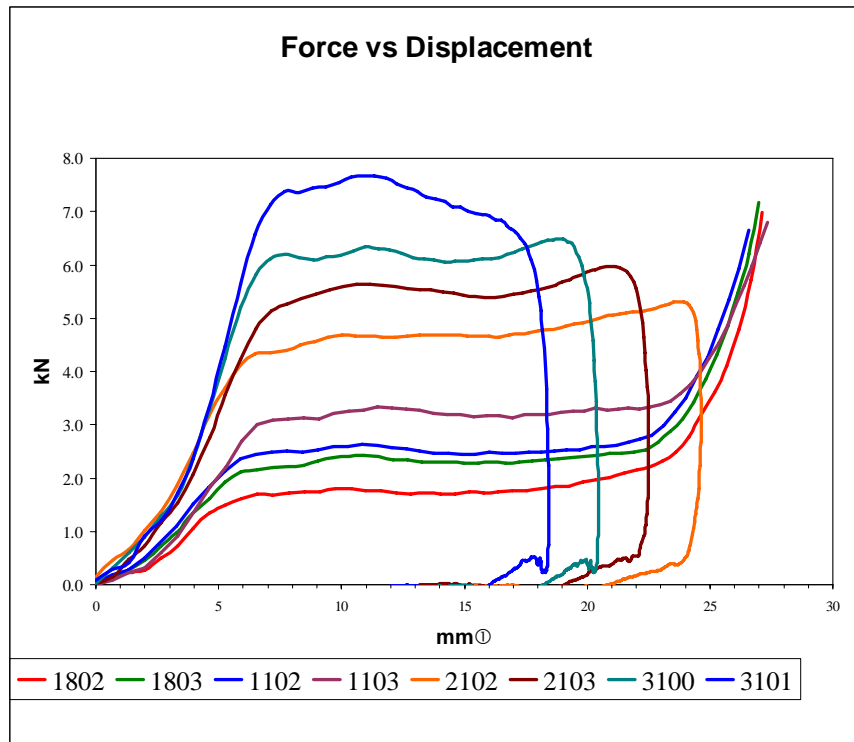
Performance, 201U

Article: **O-EA Tube, Varied layers & constructions**

Setup: **FMH Hybrid III against Rigid Backing Fixture**
Impact tube center, Horizontal, 0 Degrees

Test Sample: **26x26**

FMH mass: **4490 g**
Test speed: **24 kph**



⓪ Including FMH Headskin deflection from actual test data.

- Infinite tuning between max-min curves.
- Major load factors are aluminum thickness and layer multiples.
- Shown is 26x26 shape with various constructions.

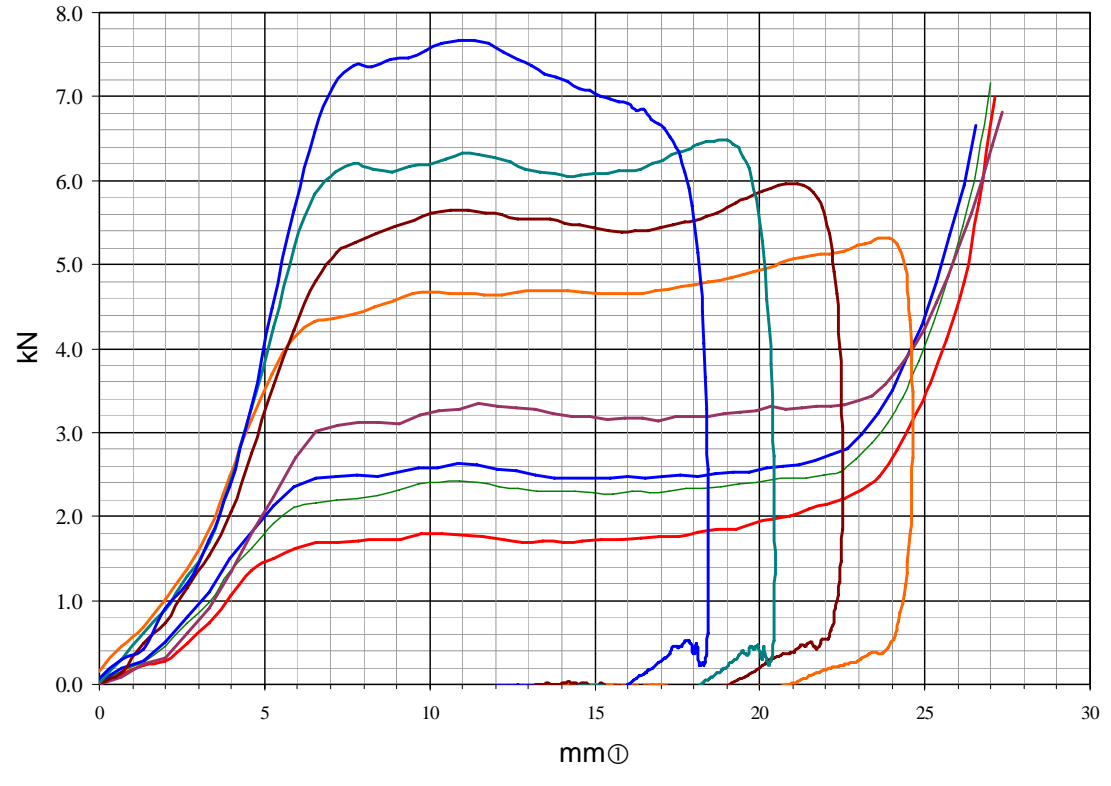
Force vs. Displacement

Dynamic Test Result

26x26 Square x 150mm

Typical load curves; tube tuning may be varied infinitely between minimum and maximum curves shown.

FMH Hybrid III, 10 lbm, 15mph, Rigid backing fixture, total deflection includes skin.



Value-Added Operations



- Punching
- Retainer Clips
- Ink Jet Printing
- Line Marking
- Anti-Rattle, Noise Suppression Materials
- Optional Colored Paper

Applications & Attachment



- Hot Melt
- Plastic clips
- Strip Adhesive
- Heat staking
- Metal tabs
- Rib mold insert
- Foam pocket

O-EA Tubes – Side Impact

The O-Flex O-EA™ tube products help our customers meet and or exceed Federal regulations as outlined in FVMSS 214.

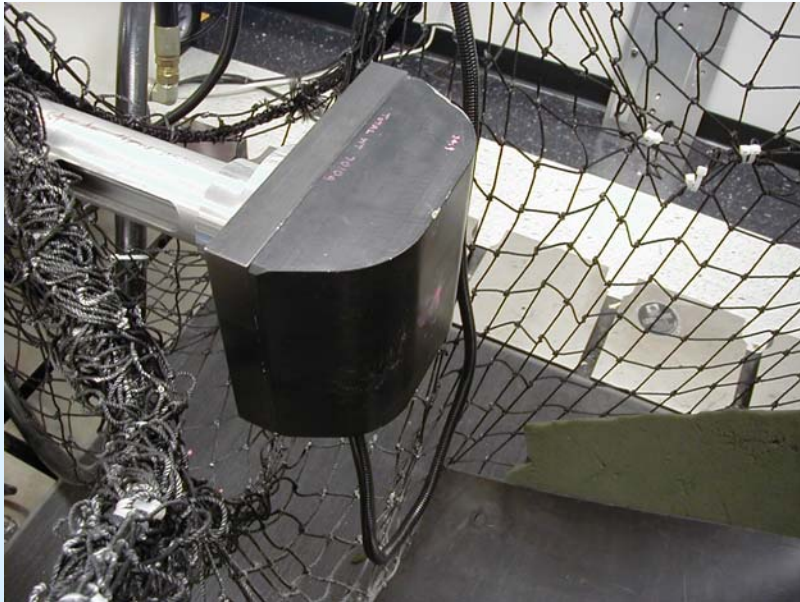
O-Flex Energy Absorbing Tubes are proving to provide one of the most cost effective and efficient countermeasures used to absorb energy during side door impact. Thoracic protection due to side impact cannot be fully realized solely through the use of the door structure. Energy absorption during impact is critical for occupant protection. The area of crush zone is also limited due to vehicle door design and component installations. The O-EA tube offered by O-Flex can be utilized in most cases without altering the door design envelop.

Within the limited space and peak forces required, O-EA tubes are an excellent choice for Side Door Impact countermeasures. For difficult applications, O-EA tubes can offer a variety of shapes and loads to achieve energy absorption levels in excess of 300 Joules within peak load requirements. Load strengths can be matched to an application to provide the maximum energy absorption possible for the limited space available.

O-Flex cost effectiveness versus performance is premium for door crush spaces between 25mm and 100mm.

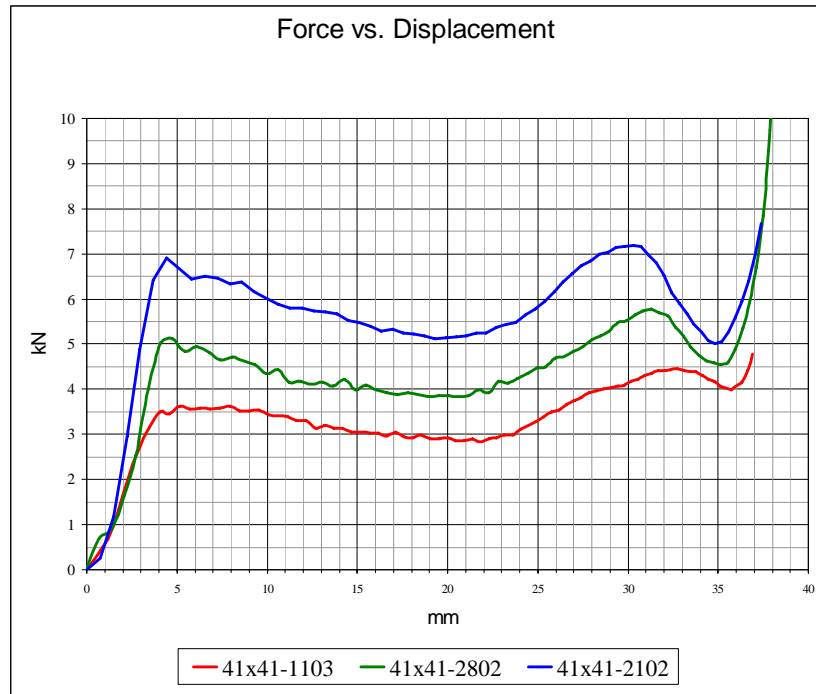
5 Star Safety Ratings have been achieved by OEM's for side impact utilizing the O-Flex O-EA™ tube.

Side Impact Test



- Aluminum form to simulate thoracic shape
- Impactor weight 21 lbs
- 18mph capability

Performance, 214L



- Load rate is achieved quickly for high percentage energy absorption per unit deflection
- Load is maintained until wall to wall contact

O-EA™ Tubes – Pedestrian Impact Protection

O-Flex Energy Absorbing Tubes are proving to be a highly cost effective and efficient measures to reduce the injury to pedestrians during a frontal collision. Pedestrian protection has become a critical area of automotive engineering in both Europe and Asia. North American OEM's are now beginning to react to the need for pedestrian protection measures utilizing vehicle design and countermeasures.

The application areas in the vehicle utilizing “Pedestrian Impact” construction are:

- Front Bumper areas
- Frontal sheet metal zones

The O-Flex O-EA™ tube product has been released for production in 2005 by several Japanese automotive manufacturers for pedestrian impact protection. The product being located in the front sheet metal areas.

ENERGY ABSORPTION COUNTERMEASURE Comparisons

O-Flex O-EA Tube

Temperature resistant
Low tooling cost & timing
Quick and easy load
variations
Fast Prototyping
Predictable performance

Plastic Countermeasures

Temperature sensitive
High tooling costs
Development time & costs are high
Modeling accuracy not always
dependable

Metal Countermeasures

Long tooling lead time & costs for
stampings
Specific geometries required to maintain
high weight/strength ratio
Honeycomb products have high piece
price per coverage area

O-EATM Technical Information

- Most widely used for attachment to pillar trim, onto headliners, around sunroof assemblies, and along side rails.
- High energy absorption per unit deflection with 80% useable crush space.
- Wide range of load tuning from 1.0 to 8.0kN+ within a given shape or size.
- Load changes can be specified and changed quickly for fast-paced testing requirements.
- Special tube section geometries possible.

O-EATM Performance

(Acrobat files)

Load range data

Square vs Round Tube Load

Irregular vs Rectangle Tube Load

HIC Reduction Chart

Temperature-Environmental Impact