

## KEYWORDS

Penetration Mechanics

Armor Mechanics

Long-Rod Penetrators

Small Arms

Body Armor

Ballistic Testing

Terminal Ballistics

Ballistic Impact

Fragment-Simulating  
Projectiles

FSP

Shaped Charges

Armor Concepts

Armor Concept  
Evaluation

Passive Armor

Reactive Armor

Active Armor

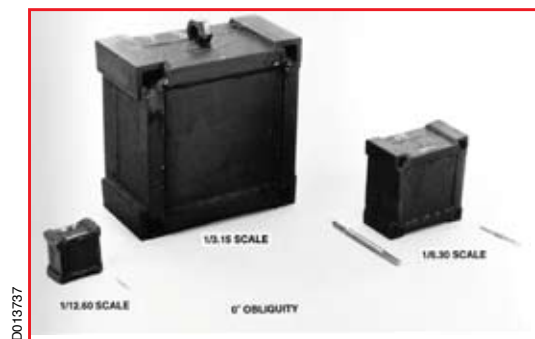
Homeland Security

**S**outhwest Research Institute (SwRI) has been involved in armor mechanics, armor concepts, and design and evaluation for over 30 years, including experimental, analytical, and computational studies. The staff is internationally recognized for their contributions to fundamental and applied understanding of penetration and armor mechanics.

An integrated approach—experimentation, numerical simulation, and analytical modeling—is used to investigate and solve fundamental and applied problems in armor mechanics, armor applications and armor design, including reactive and active armor systems. High-speed diagnostics and a wide variety of launchers are used to support experimental studies. A complementary high-rate materials laboratory allows material characterization and determination of computational constitutive constants.

## *Applications and Experience*

- Low-speed impact
- Small arms
- Anti-tank kinetic energy projectiles
- Chemical energy threats
- Armor efficiency assessment
- Evaluation of penetrator defeat mechanisms
- Testing of passive, reactive, and active armors



*Scale-model ceramic laminate (RHA / Al<sub>2</sub>O<sub>3</sub> / RHA) targets*



*Numerical simulation of a long-rod projectile against a spaced-armor array*

## *Armor Technologies*

### Types of Armor

- Monolithic
- Multi-material
- Multi-component
- Spaced plate
- Heavy
- Light
- Reactive
- Active

### Materials

- Metallics
- Ceramics
- Composites
- Fabrics
- Explosives
- Inert elements

### Projectiles/Threats

- Long rods
- Medium caliber
  - 14.5 (B32, BS41)
  - 30-mm AP
  - 30-mm APDS
- Small arms
  - Rifle
  - Handgun
  - Armor-piercing
  - Ball
- FSPs
- Shaped charges

### Defeat Mechanisms

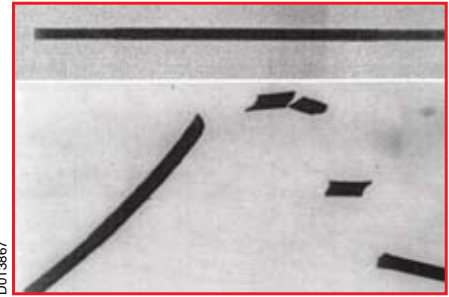
- Target strength
- Obliquity
- Fracture
- Yaw
- Rotation
- Spaced elements
- Erosion
- Spreading the load

### Applications

- Ballistic limit
- Ballistic protection design
- Concept evaluation
- Design improvements

## Facilities

- Indoor ballistics range
- 20/30-mm high-performance gun system
- 50-mm high-performance cannon (impact velocities up to ~2.0 km/s)
- Outdoor test areas, up to 1000 yards
- Storage, handling, and application of explosives
- Fully equipped instrumentation trailer (high-speed data acquisition of pressure, strain, displacement, etc.)
- Flash radiography
- High-speed video (up to 60,000 frames per second)
- Ultra-high-speed digital imaging (up to 100 million frames per second)



D013867

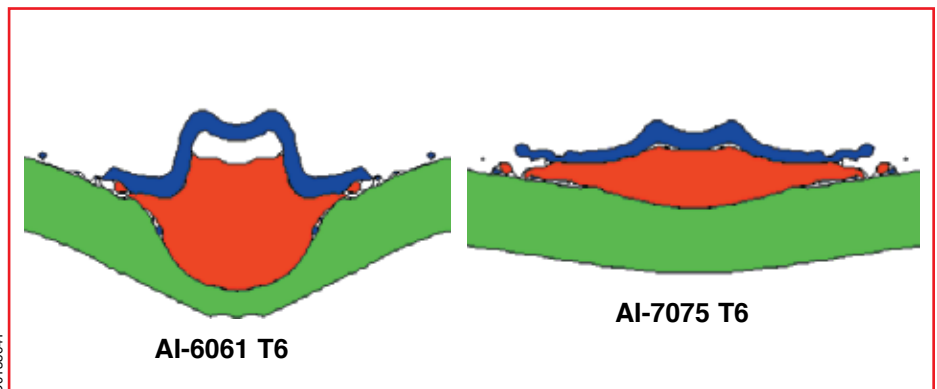
*Flash x-ray of a long-rod projectile in flight (top); same projectile after impact to induce fracture (bottom)*



D013866

*Damaged ceramic tile, impacted by a 7.62-mm APM2 bullet*

*Response of two types of aluminum alloys to impact by a lead-filled ball round*



D0138641



*Southwest Research Institute is an independent, nonprofit, applied engineering and physical sciences research and development organization using multidisciplinary approaches to problem solving. The Institute occupies 1,200 acres in San Antonio, Texas, and provides more than 2 million square feet of laboratories, test facilities, workshops and offices for more than 3,300 employees who perform contract work for industry and government clients.*

**We welcome your inquiries. For additional information, please contact:**

Charles E. Anderson, Jr., Ph.D.  
 Director, Engineering Dynamics Department  
 (210) 522-2313  
 charles.anderson@swri.org

James D. Walker, Ph.D.  
 Staff Scientist, Computational Mechanics Section  
 (210) 522-2051  
 james.walker@swri.org

Engineering Dynamics Department  
 Mechanical and Materials Engineering Division  
 Southwest Research Institute  
 6220 Culebra Road • P.O. Drawer 28510  
 San Antonio, Texas 78228-0510

Southwest Research Institute Website:  
[www.swri.org](http://www.swri.org)  
 Engineering Dynamics Department Website:  
[www.engdyn.swri.org](http://www.engdyn.swri.org)