

Bullet Striking Steel Armor with Two Plates

1. Problem definition.

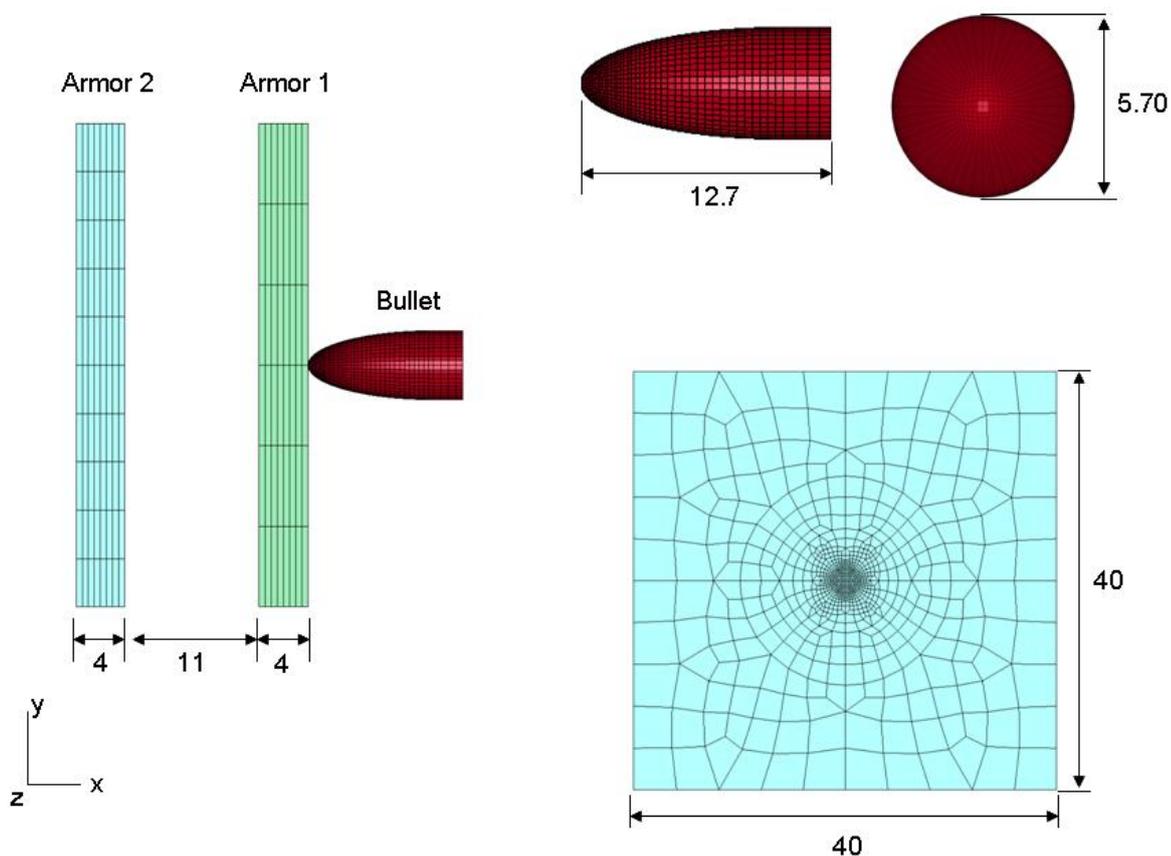
A bullet of caliber 5.56x45mm (NATO standard, originally chambered for M16) is hitting a structure with two separated steel plates. The bullet impact velocity is 200 m/s and 400 m/s.

The plate is 4mm thick for each. Distance between two plates is 11mm.

We have set up a set of simulation of this case using LS-DYNA ver.970 (personal version). The details are described below.

2. Model definition

The problem is simplified as described in the figure. Mesh profile is also shown. Size dimension are in mm.



3. Simulation conditions

1) Material Model

Usually bullet is made from copper as jacket and lead as core. For simplification, the bullet used here has copper's Young Modulus, but has lead (Pb) properties for mass density and Poisson's ratio.

The armors are made from high strength steel, typically the same as SUJ2 steel. But they have no bullet proof characteristics.

Material behavior:

Bullet and armors are modeled with *Mat_Plastic_Kinematic* behavior. In this material model, kinematic hardening is considered with bi-linear model, but strain effect and Johnson-Cook option is ignored. Eroding option is activated to allow deletion of elements which have already reached their failure strain.

The material details are as listed below

Material Property	Bullet	Armor
Yield stress [GPa]	1.0	1.5
Young Modulus [GPa]	110	208
Work hardening gradient (bi-linear model). [GPa per 1 unit plastic strain]	5	3
Failure strain F_s	2.0	0.3
Poisson's ratio	0.44	0.28
Density [gr/m ³]	4 gr weight	7.82e-6

2) Impact conditions

Condition	Velocity	Rotation
Strike1	200 m/s	NA
Strike2	400 m/s	NA
Strike3	400 m/s	180,000 rpm

Simulation time: 0.2 millisecond

4.Results

Simulation results (animation):

1. [Strike 1](#)
2. [Strike 2](#)
3. [Strike 3](#)

Details

Bullet Condition

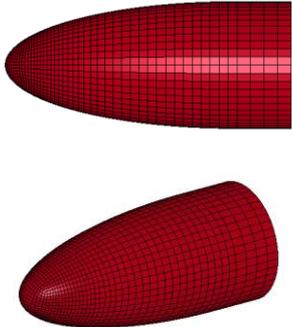
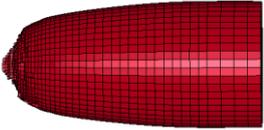
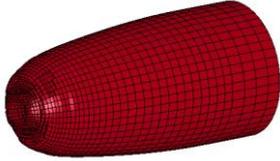
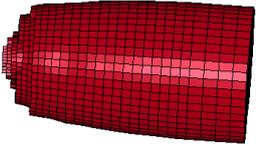
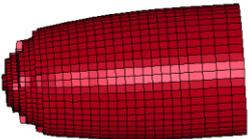
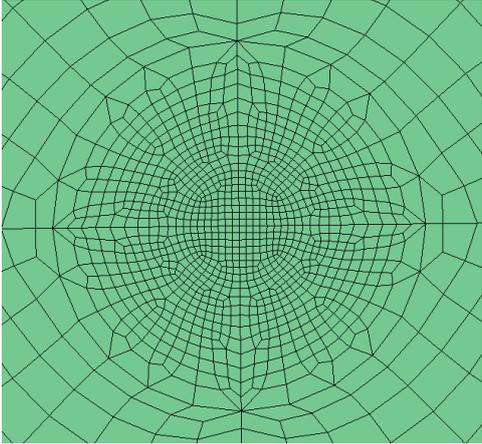
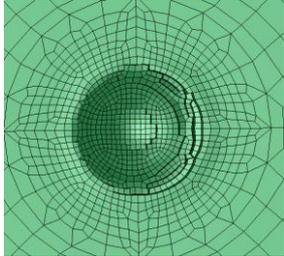
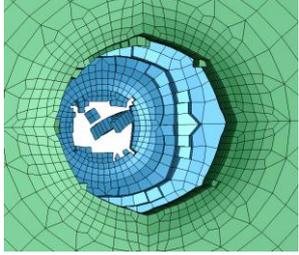
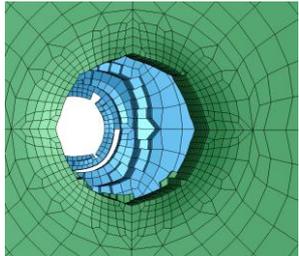
Condition	Before	After	
Strike 1			
Strike 2			
Strike 3			

Plate Condition

Condition	Plate 1 (green) and Plate 2 (blue)	
	Before (0 ms)	After (0.2 ms)
Strike 1		
Strike 2		
Strike 3		

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