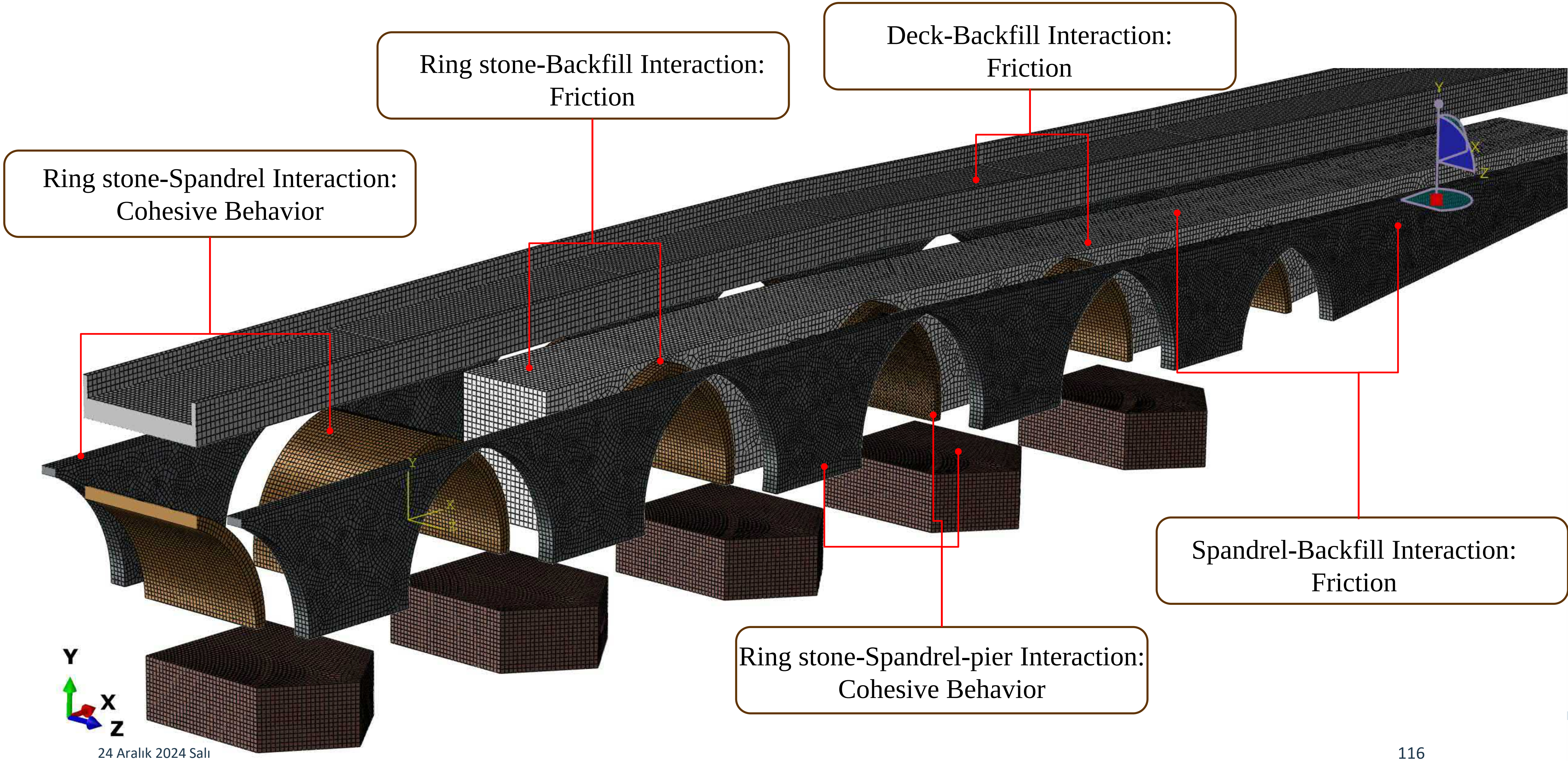
Köprülerin Tehdit Analizleri

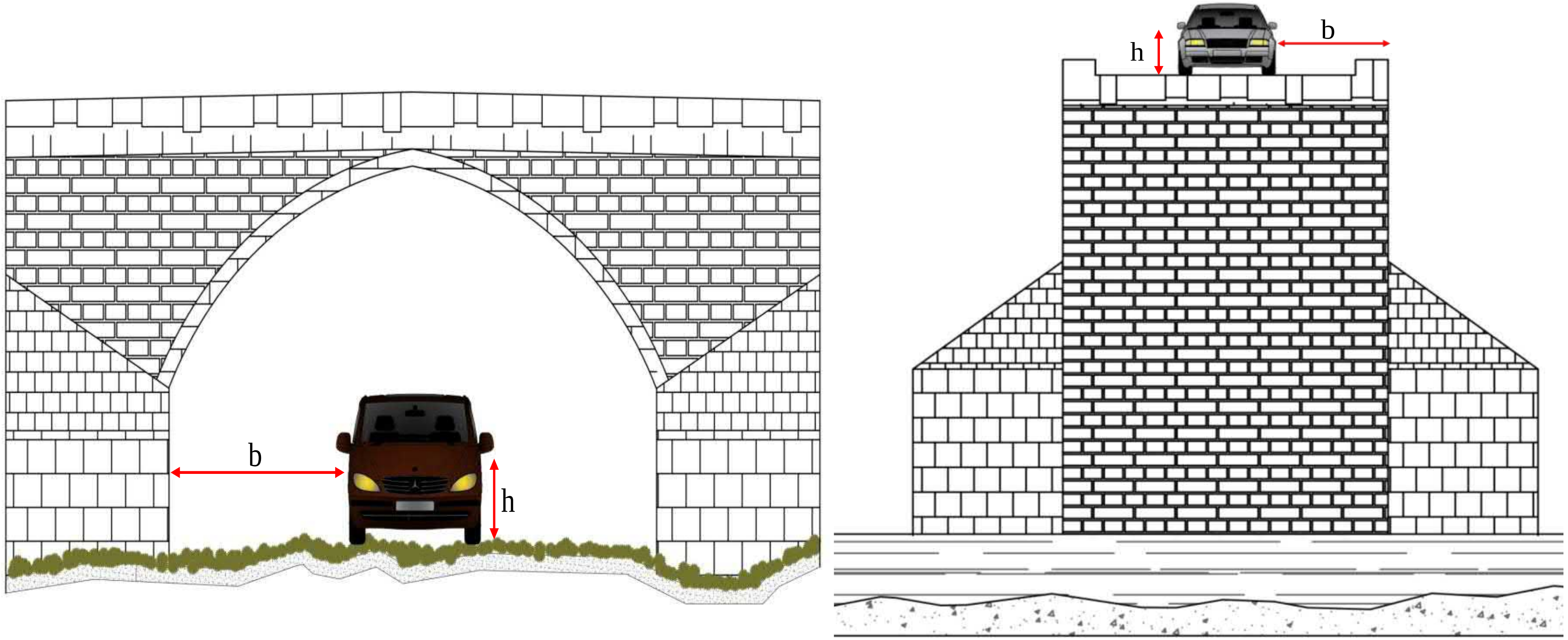
Tarihi Köprüler



Tarihi Köprüler

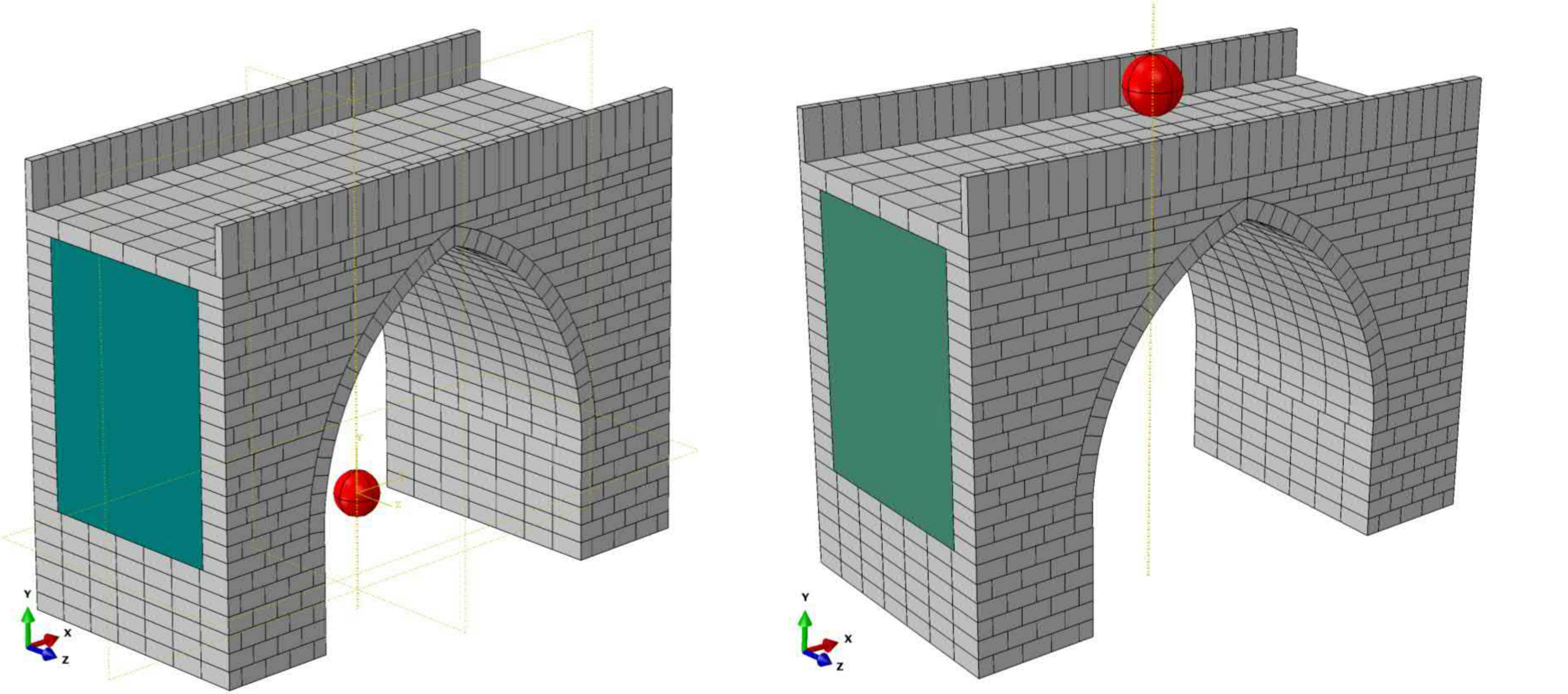
- Blast Scenarios and vehicle position beneath and above the deck.

	Compact sedan (#1)	Sedan (#2)	Van (#3)
Attack Scenarios			
Explosive (kg)	100	200	500

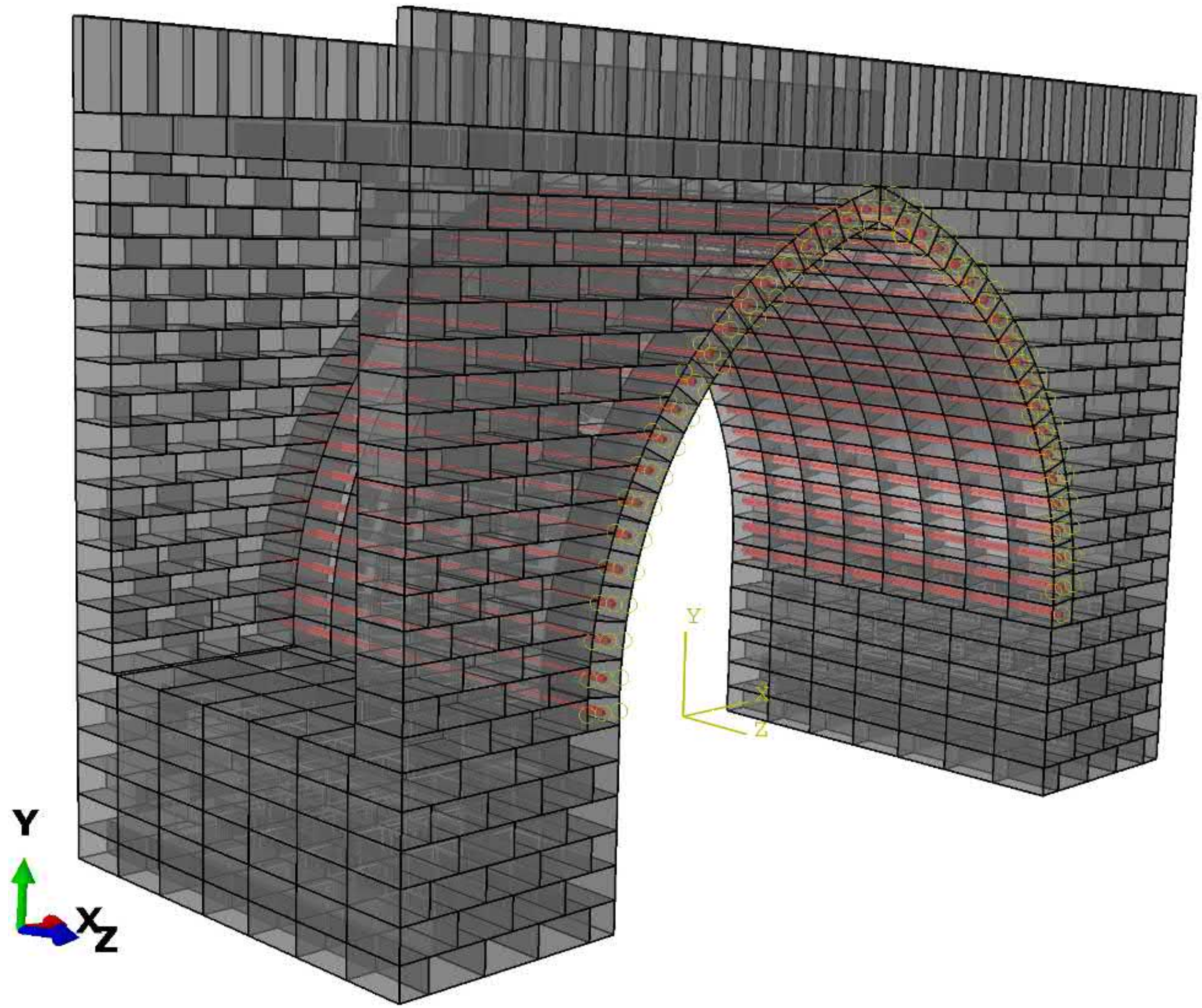


Tarihi Köprüler

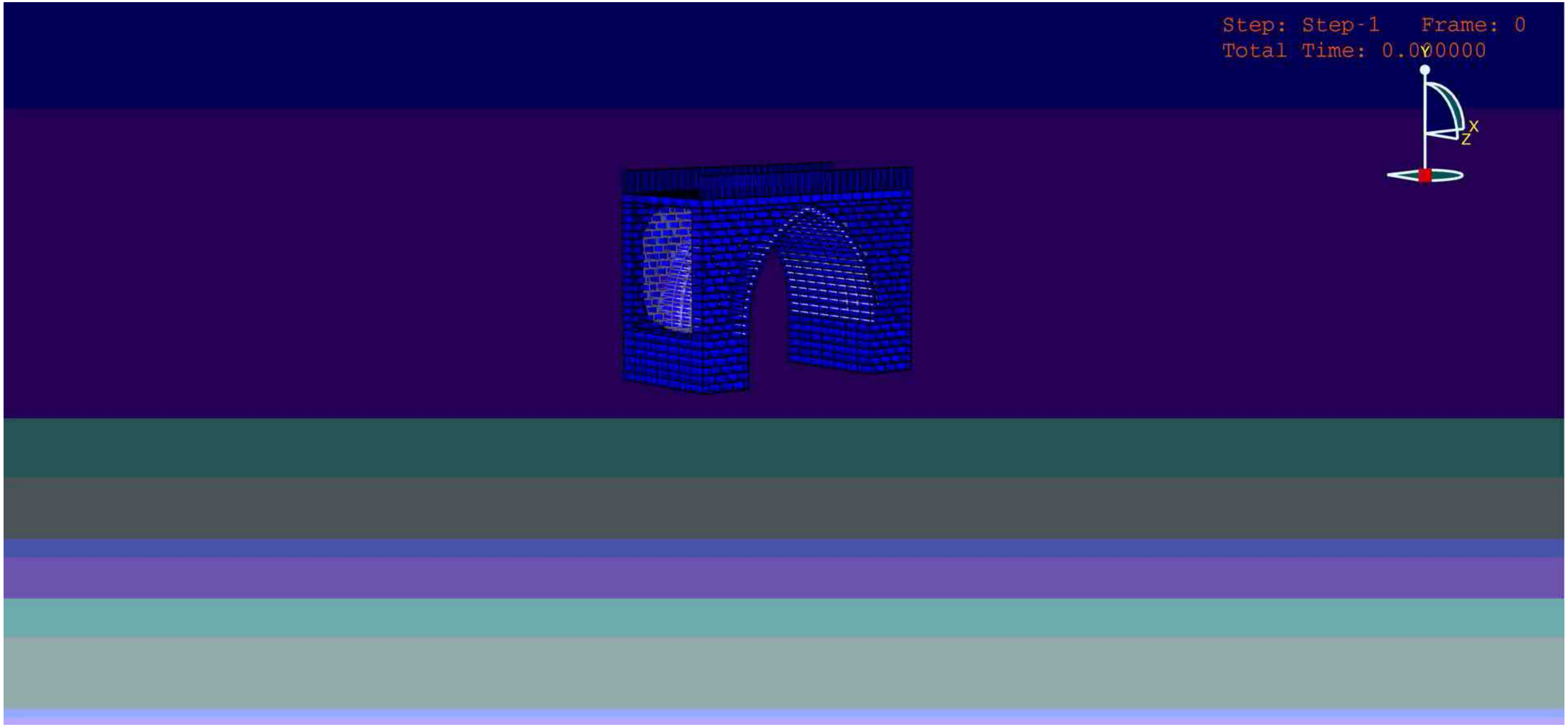
- The FE model of explosives for different scenarios; (a) below deck explosive location, (b) above deck explosive location

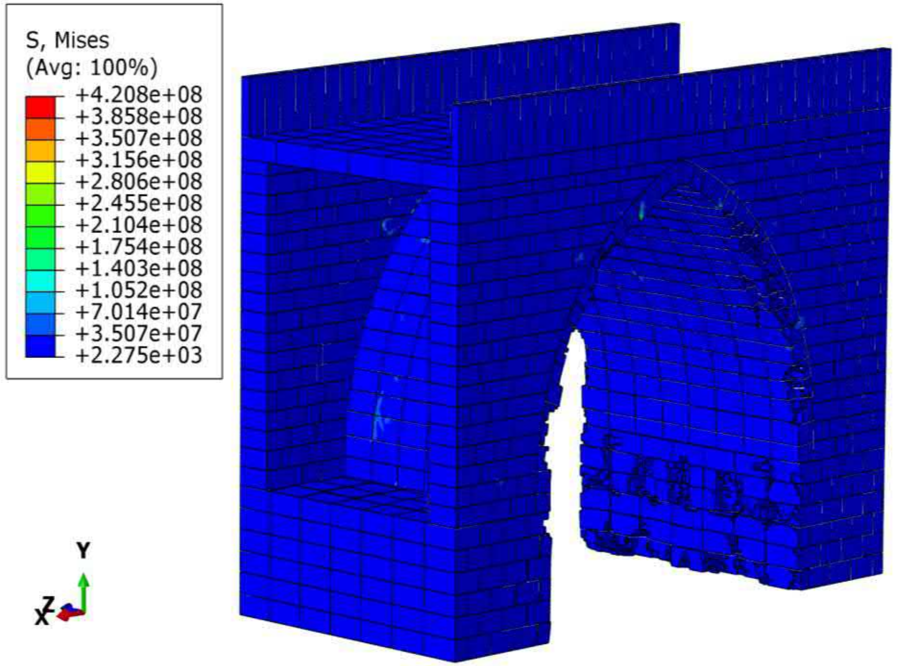


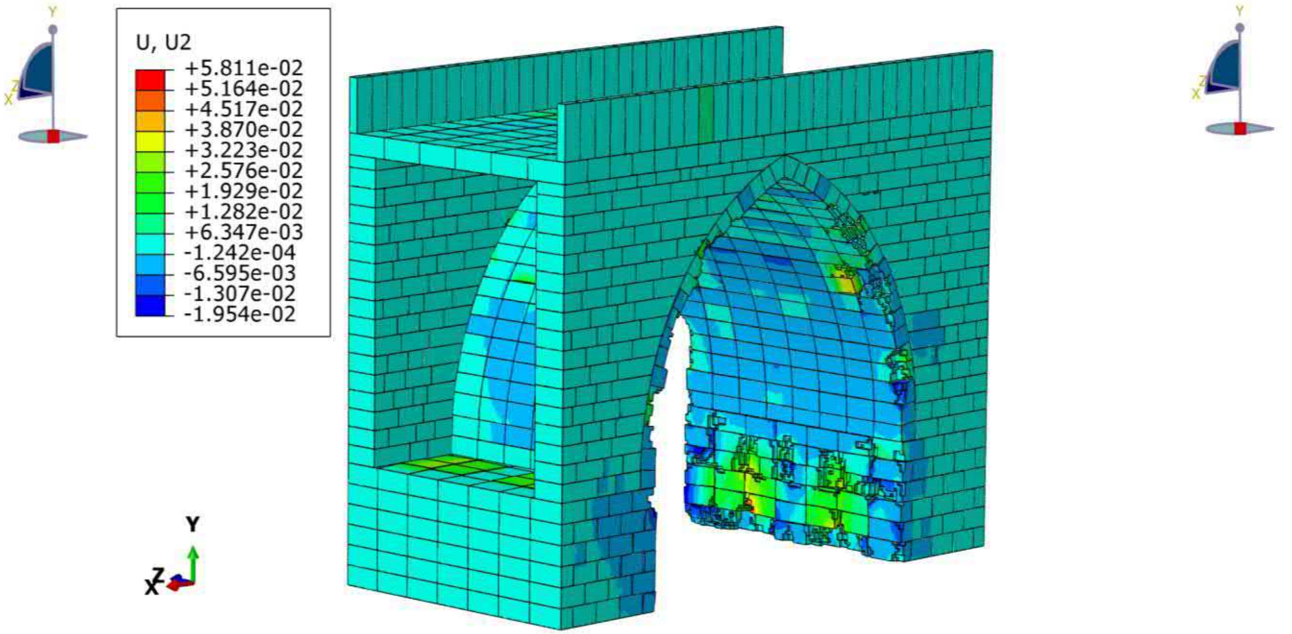
Tarihi Köprüler

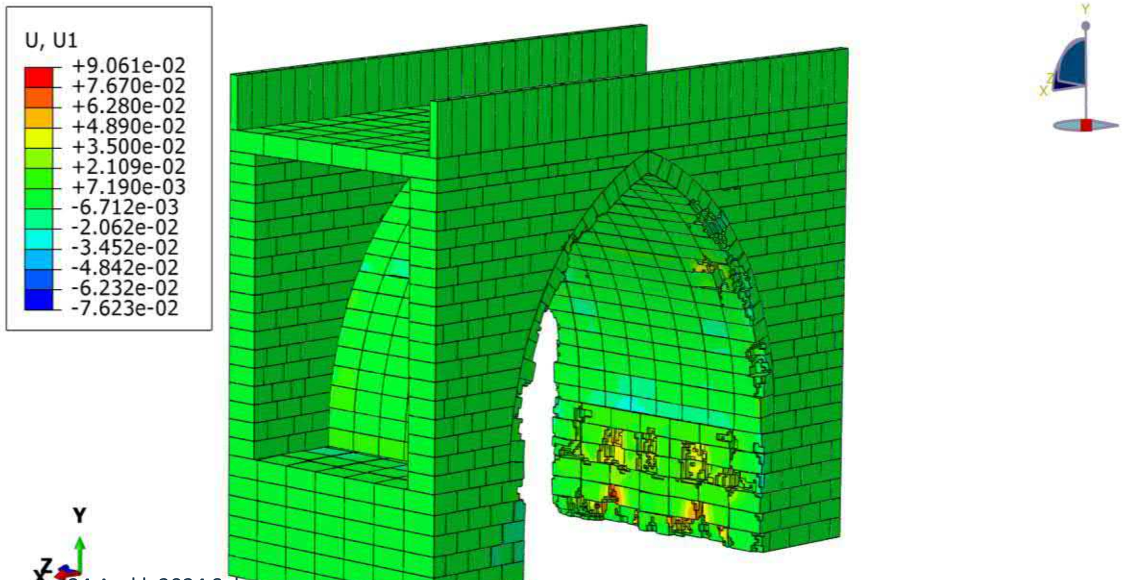


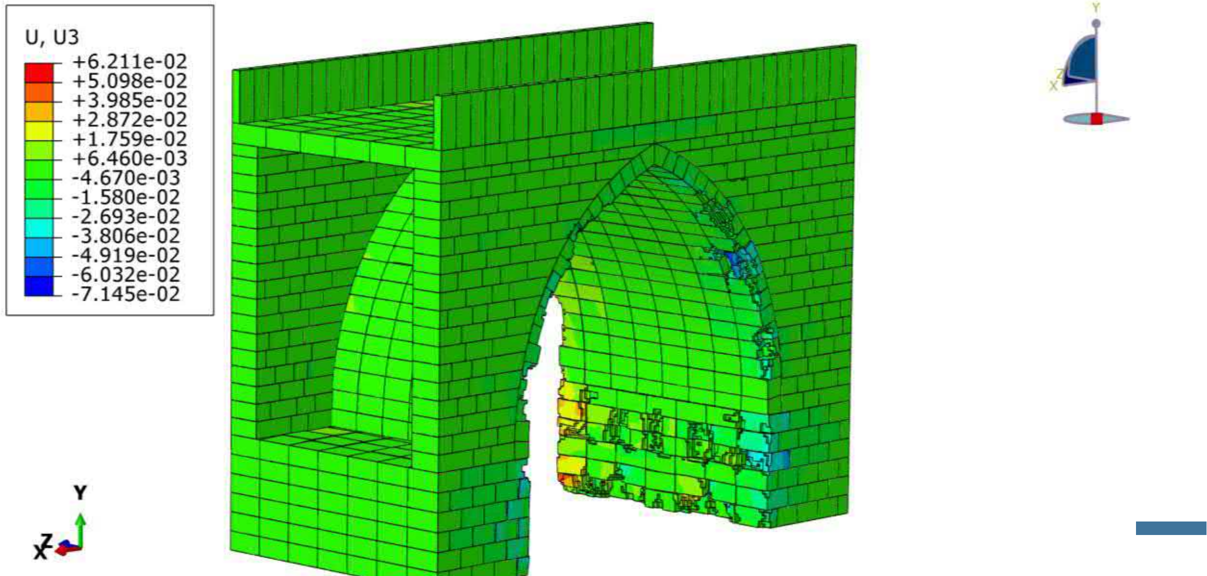
Tarihi Köprüler



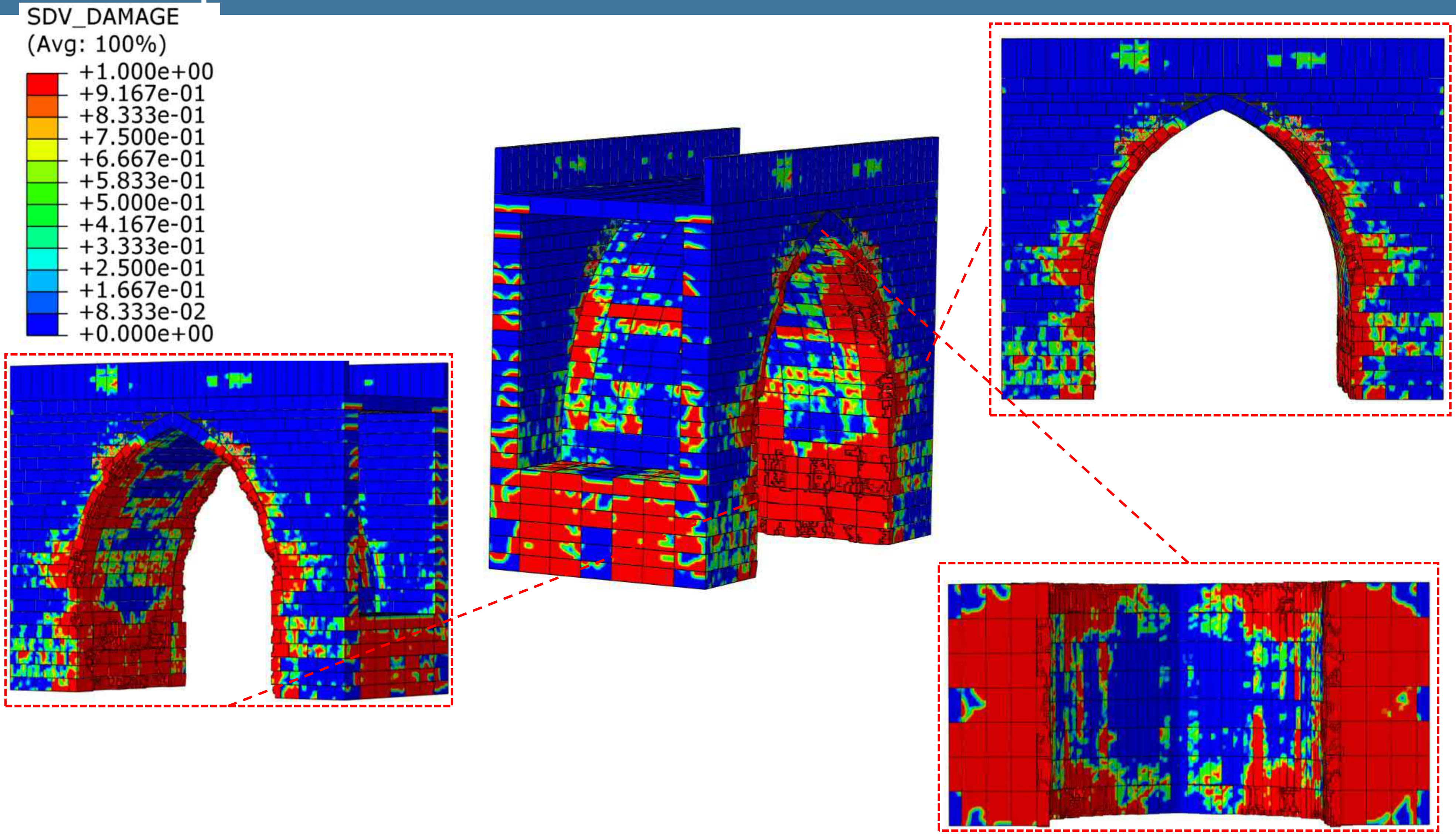

S, Mises
(Avg: 100%)
+4.208e+08
+3.858e+08
+3.507e+08
+3.156e+08
+2.806e+08
+2.455e+08
+2.104e+08
+1.754e+08
+1.403e+08
+1.052e+08
+7.014e+07
+3.507e+07
+2.275e+03
Y
Z
X


U, U2
+5.811e-02
+5.164e-02
+4.517e-02
+3.870e-02
+3.223e-02
+2.576e-02
+1.929e-02
+1.282e-02
+6.347e-03
-1.242e-04
-6.595e-03
-1.307e-02
-1.954e-02
Y
Z
X

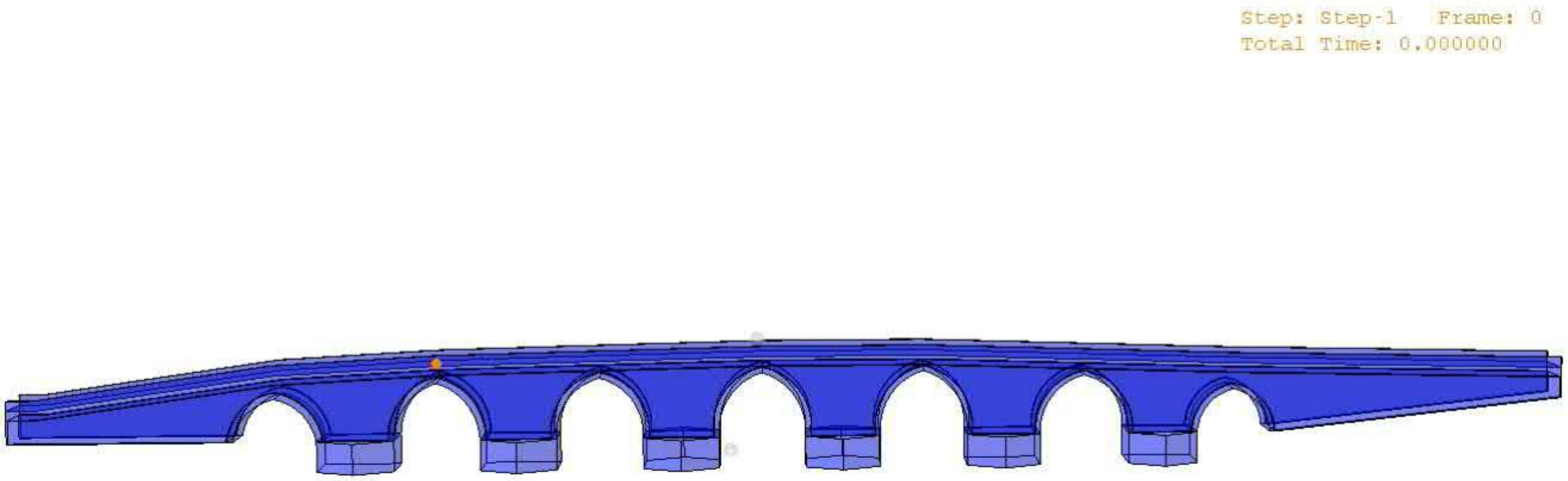

U, U1
+9.061e-02
+7.670e-02
+6.280e-02
+4.890e-02
+3.500e-02
+2.109e-02
+7.190e-03
-6.712e-03
-2.062e-02
-3.452e-02
-4.842e-02
-6.232e-02
-7.623e-02
Y
Z
X


U, U3
+6.211e-02
+5.098e-02
+3.985e-02
+2.872e-02
+1.759e-02
+6.460e-03
-4.670e-03
-1.580e-02
-2.693e-02
-3.806e-02
-4.919e-02
-6.032e-02
-7.145e-02
Y
Z
X

Tarihi Köprüler

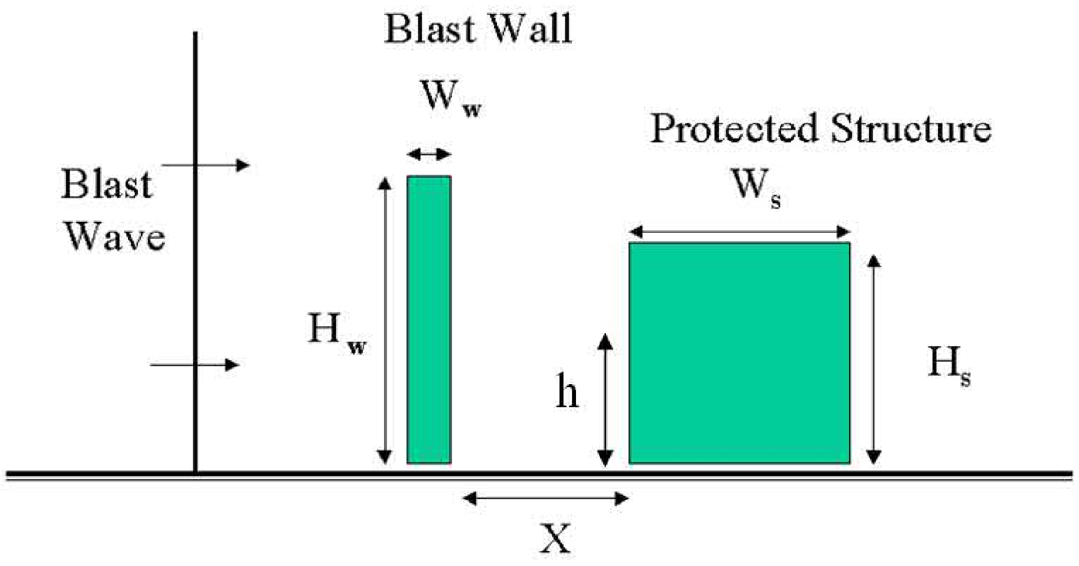


Tarihi Köprüler



Patlama Duvarları

Patlama Duvarları



h	**Target elevation**
H_S	**Structure height**
H_W	**Blast wall height**
W_S	**Structure width**
W_W	**Blast wall width**
X	**Gap distance**

h/H_S	**Normalized target elevation**
H_W/H_S	**Normalized blast wall Height**
X/H_S	**Normalized gap distance**

BL_F : Free-field blast loads at location of structure front wall
BL_A : Applied blast loads (unshielded, w/o blast wall)
BL_S : Shielded blast loads (with blast wall)

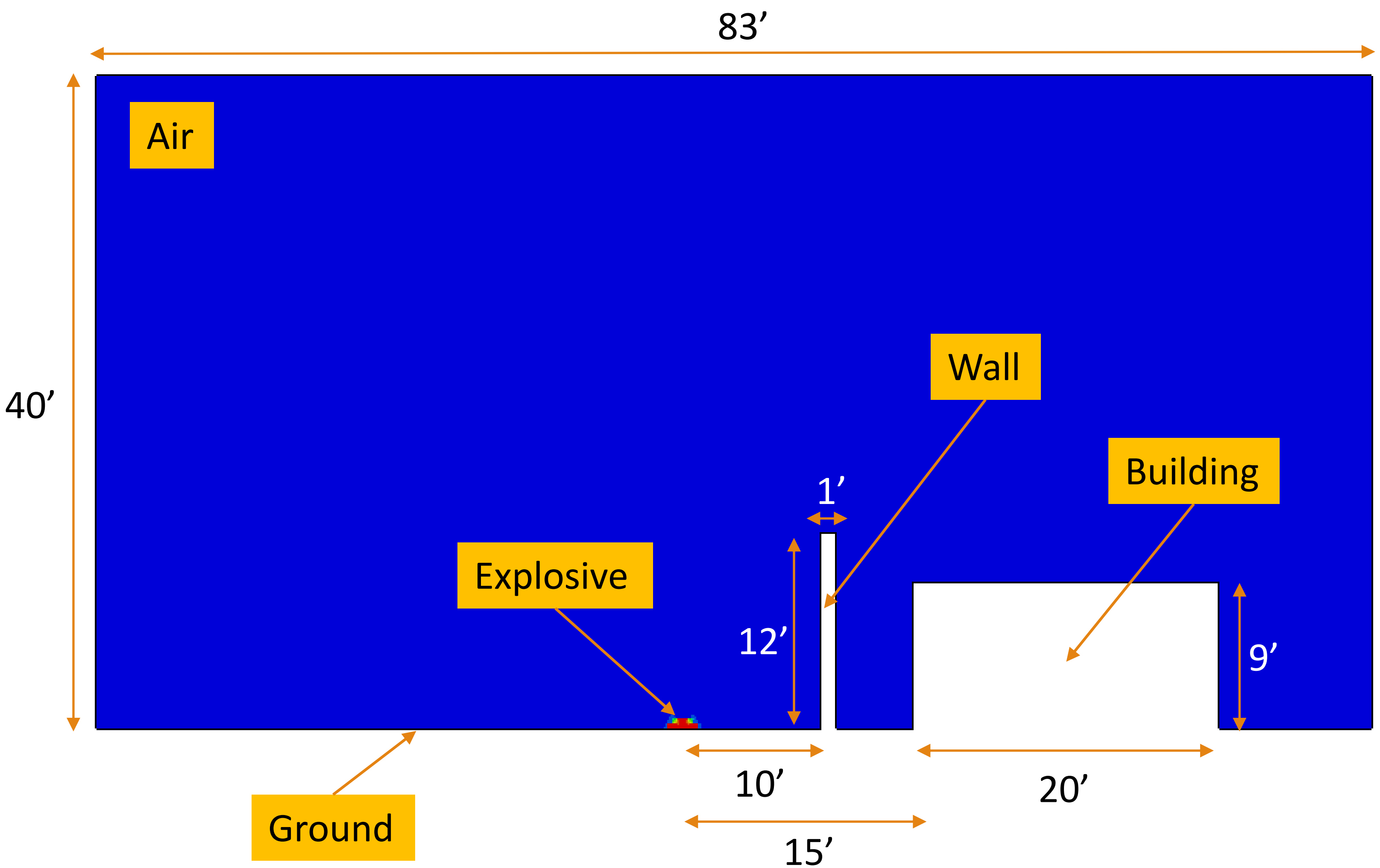
Blast Reduction:

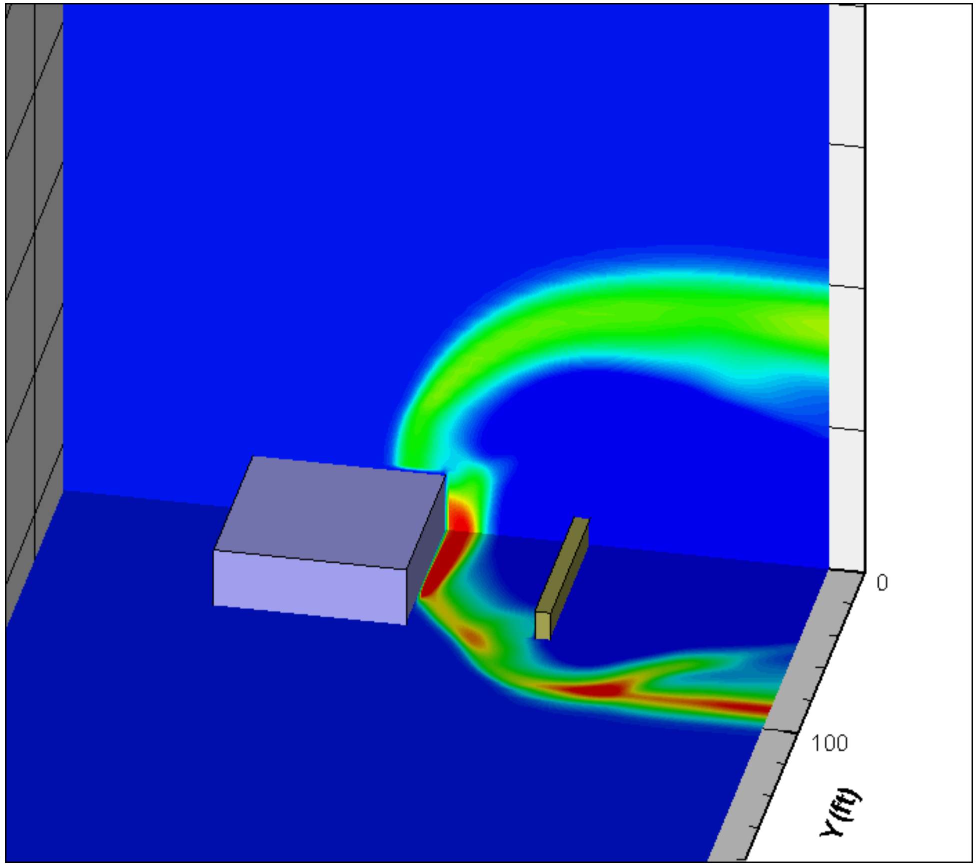
$$BL_S / BL_A = f_A\ (H_W/H_S,\ X/H_S,\ L_P/H_S,\ P_P,\ \ldots)$$

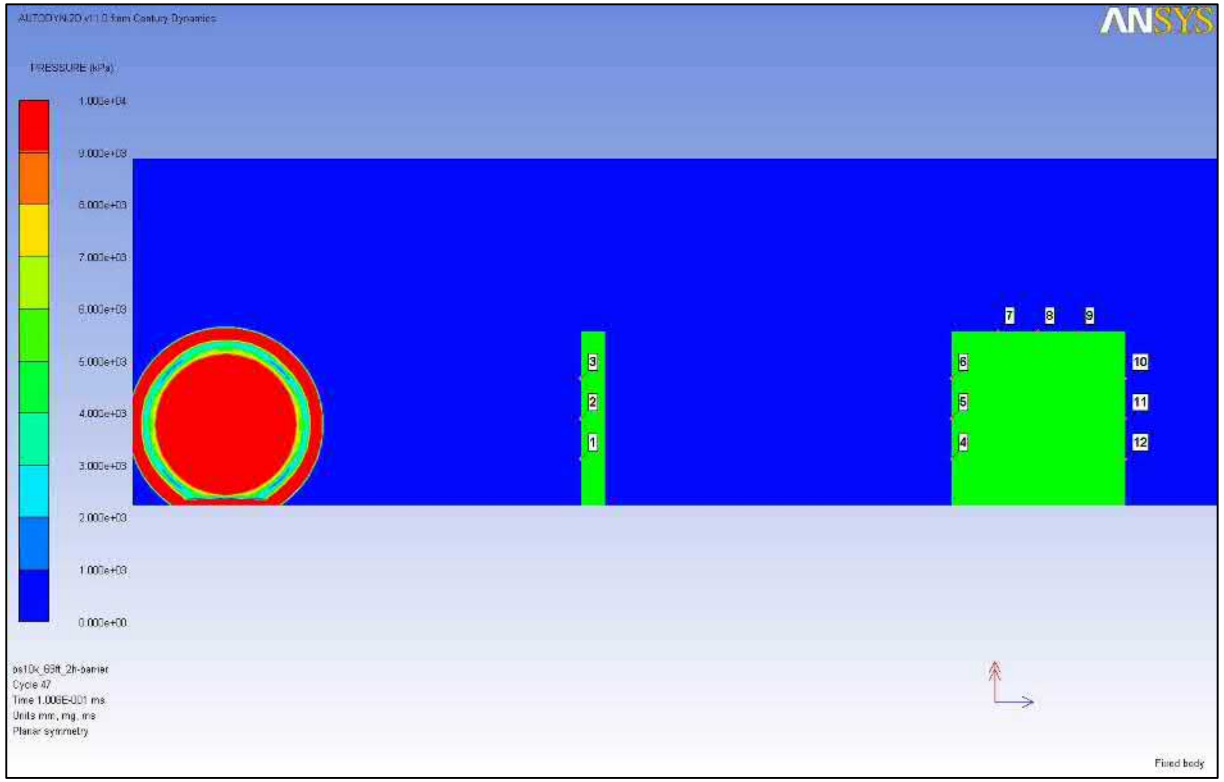
Adjustment Factor (AF):

$$BL_S / BL_F = f_F\ (H_W/H_S,\ X/H_S,\ L_P/H_S,\ P_P,\ \ldots)$$

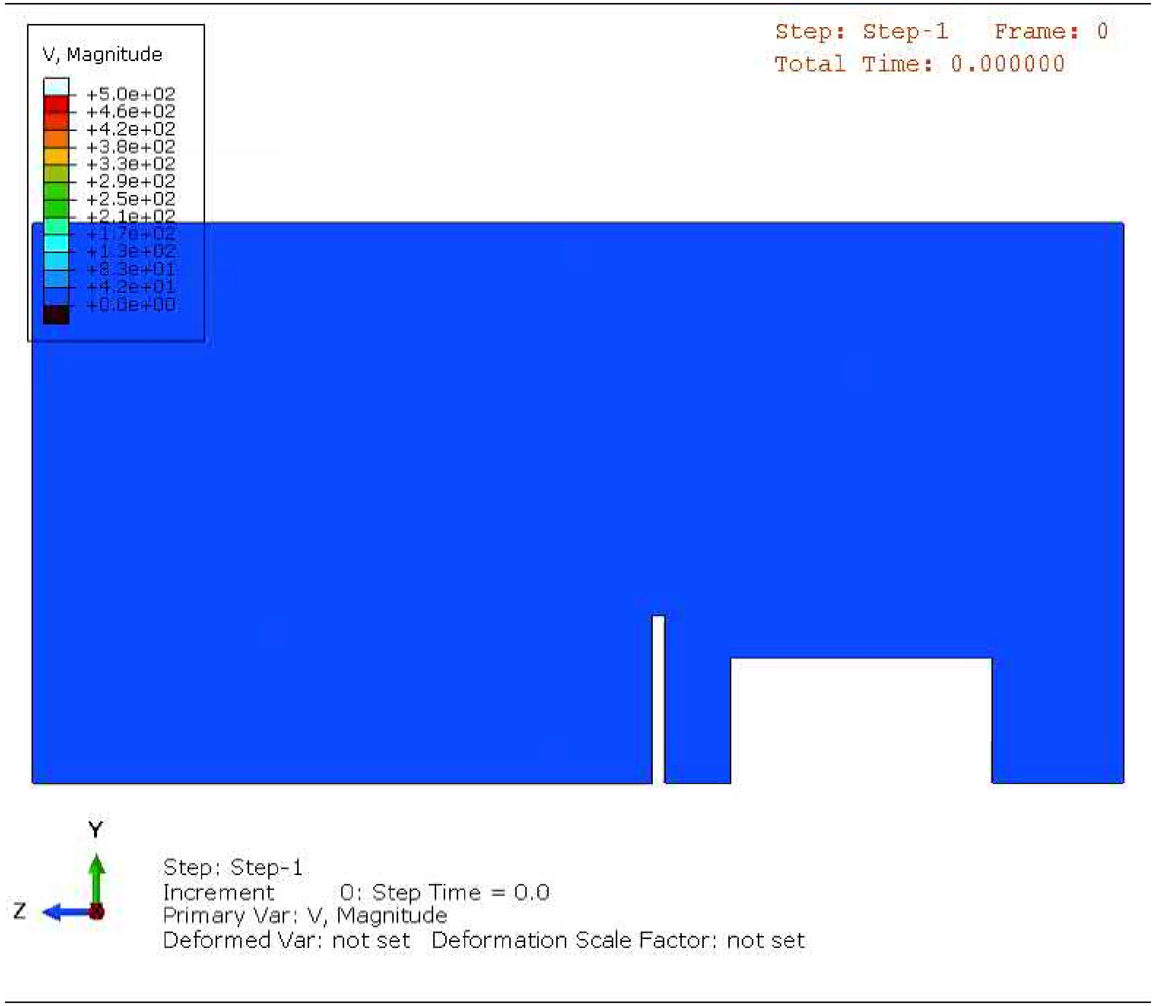
Patlama Duvarları

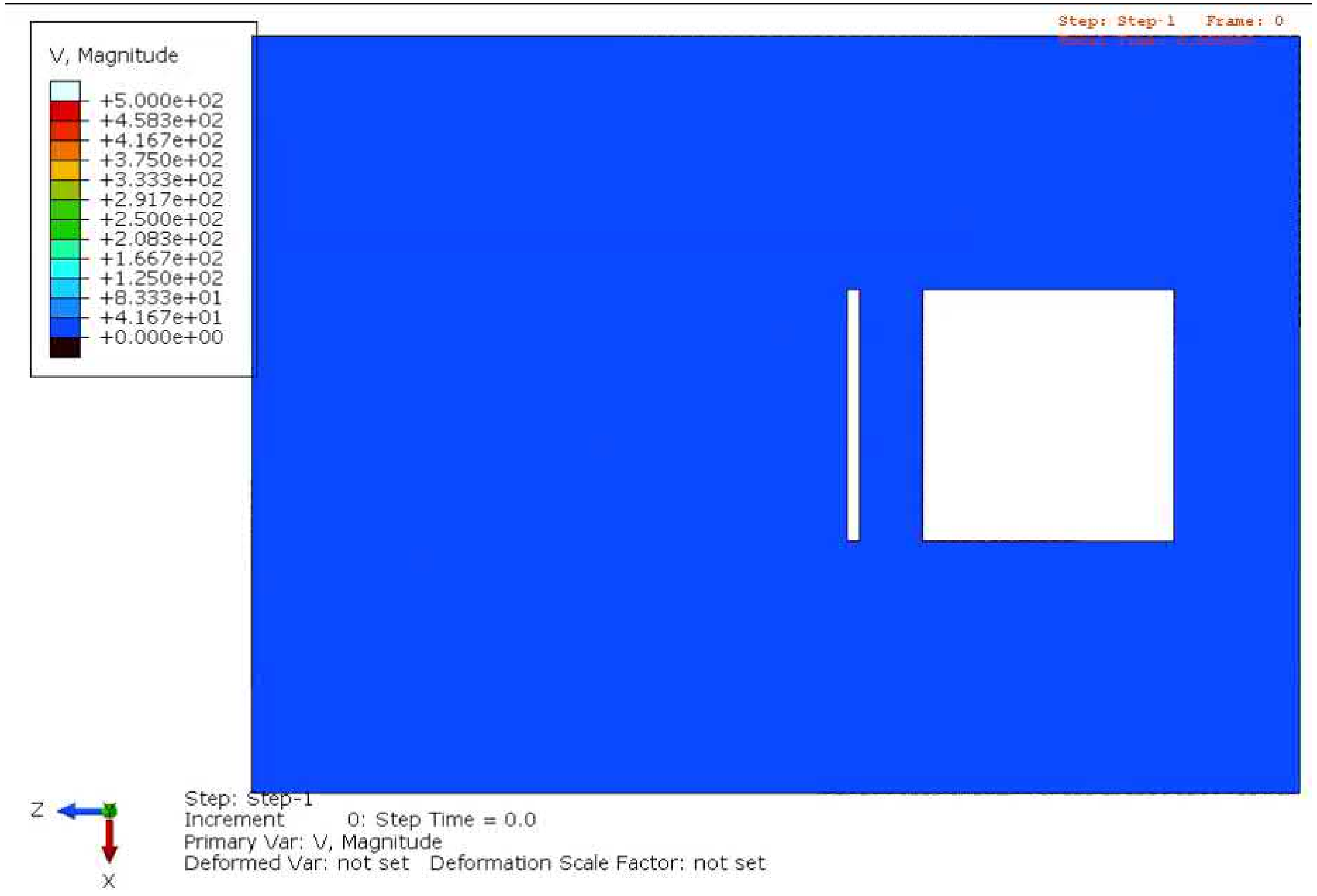



0
100
Y (ft)


AUTODYN-2D v11.0 from Century Dynamics
ANSYS
PRESSURE (kPa)
1.000e+04
9.000e+03
8.000e+03
7.000e+03
6.000e+03
5.000e+03
4.000e+03
3.000e+03
2.000e+03
1.000e+03
0.000e+00
ps10k_69ft_2h-barrier
Cycle 47
Time 1.006E-001 ms
Units mm, mg, ms
Planar symmetry
1
2
3
4
5
6
7
8
9
10
11
12
Fixed body

Patlama Duvarları

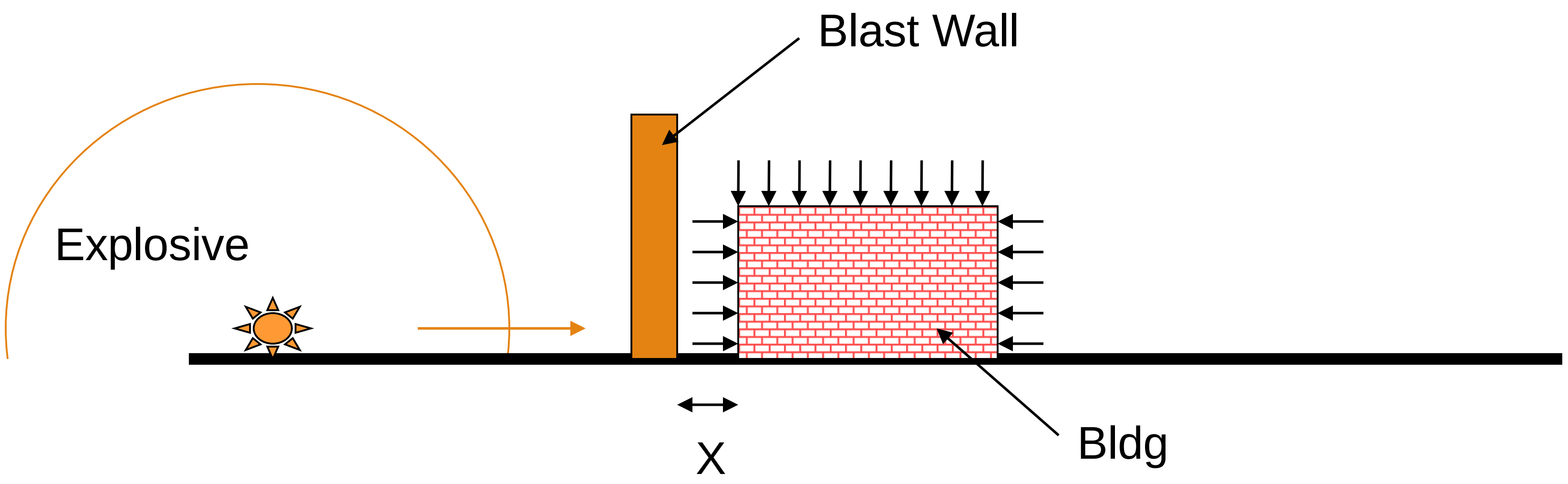




Patlama Duvarları

How high should be make the wall?

The wall should be more than 50% greater than the building height to be effective



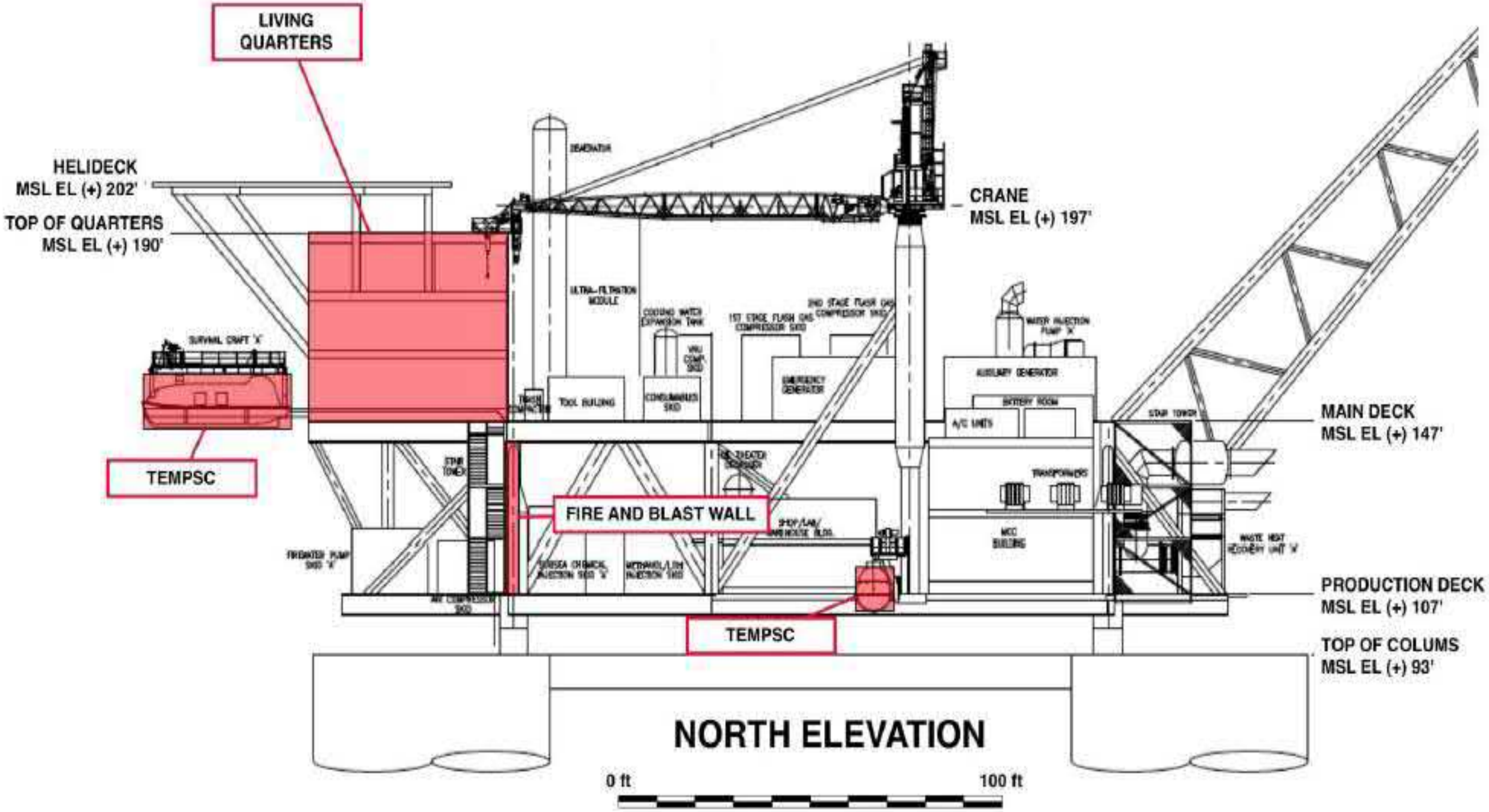
Açık Deniz Yapıları

Sevan 400 type FPSO, newly built, JV owned and Shell operated , has been selected as host facility for the Penguins Redevelopment Project (RDP).

Sevan 400 Concept (from North)

Sevan 400 Concept (from South)

Açık Deniz Yapıları – Patlama Duvarları

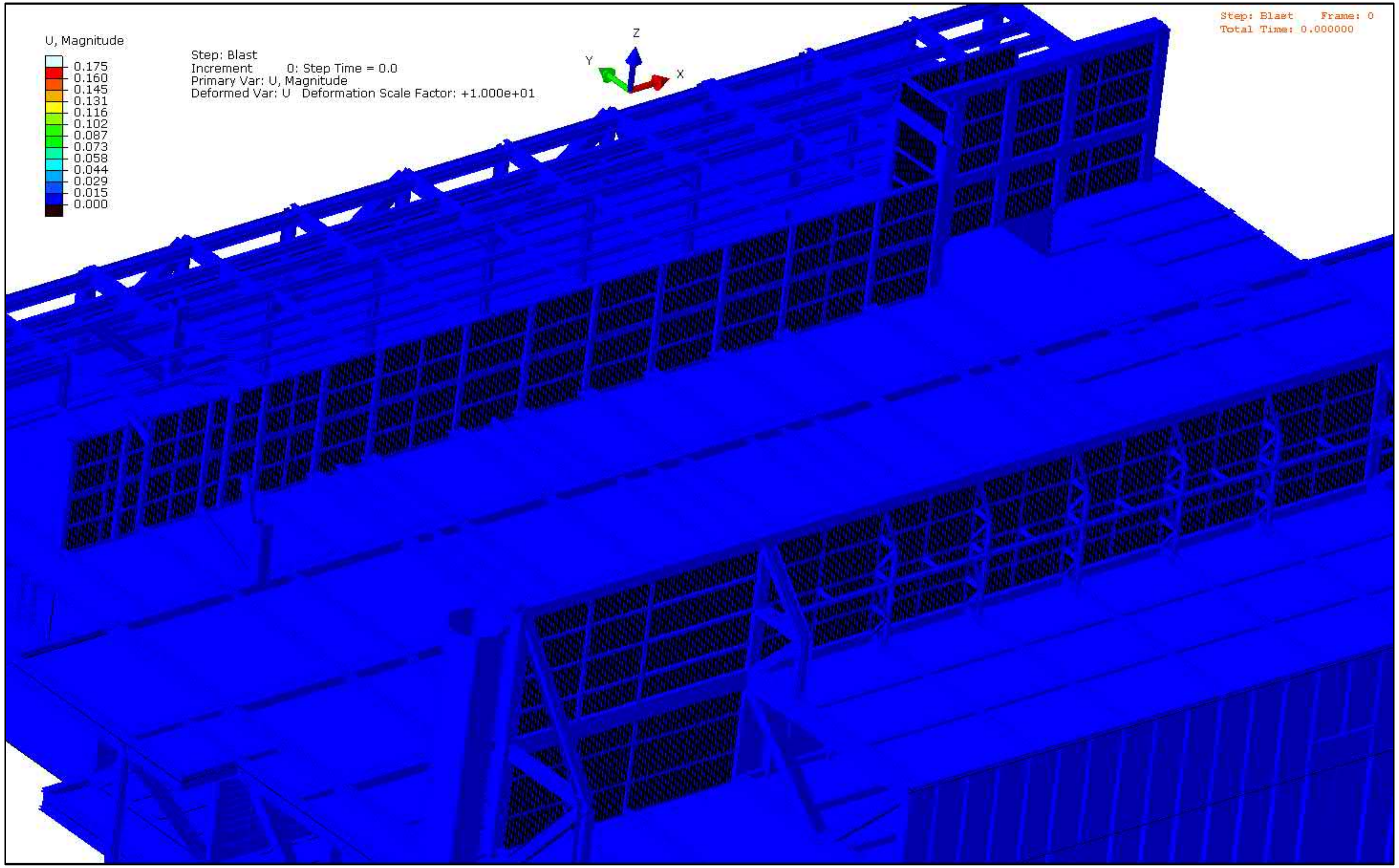


Ref. Hess Report, "Preliminary Fire and Explosion Analysis", PN1-00-EHS-RPT-000-00049, Rev. 0, Approved on 12.22.13.

Açık Deniz Yapıları – Patlama Duvarları

Picture from blast wall construction site

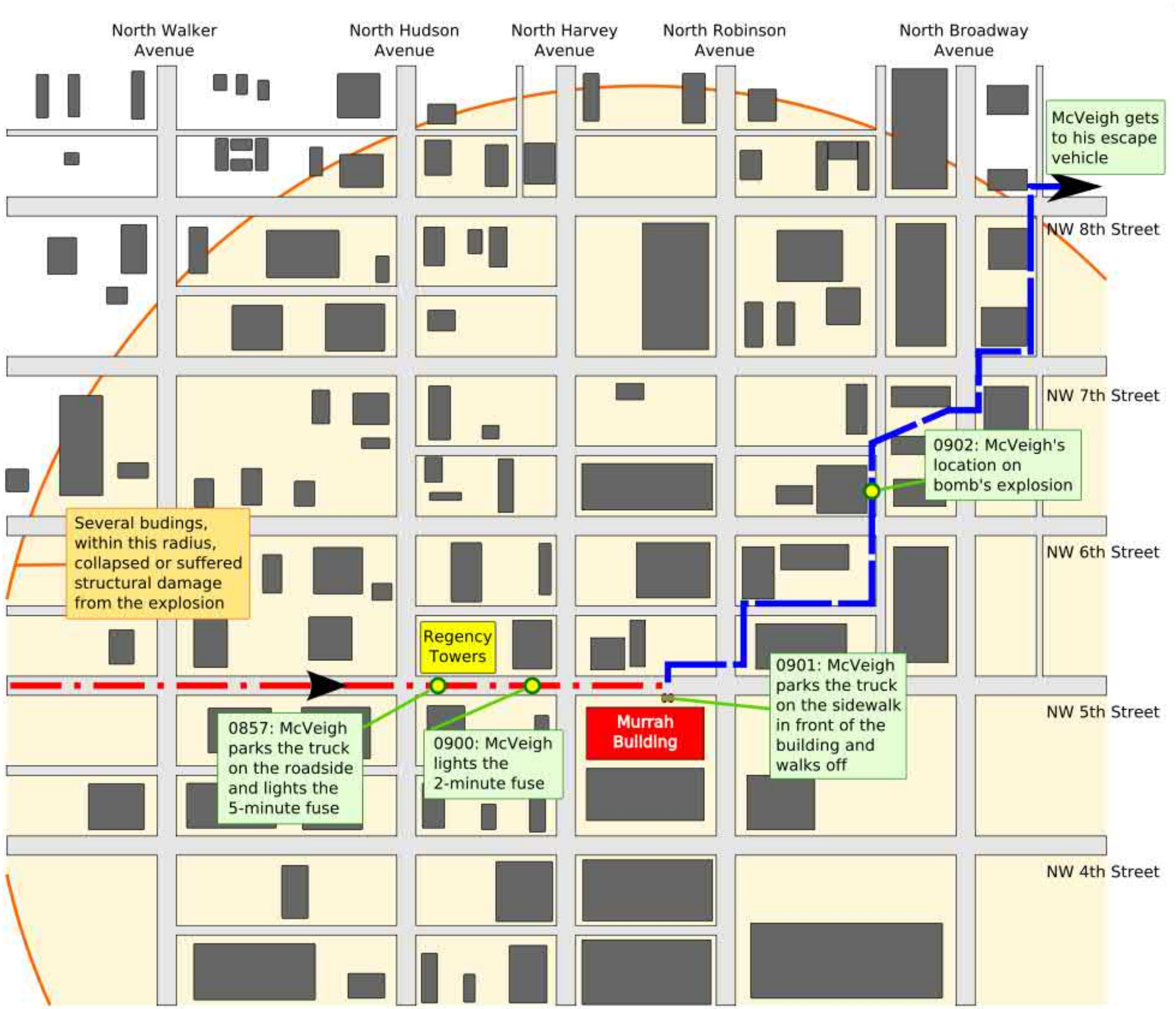
Açık Deniz Yapıları – Patlama Duvarları



Camlar

Oklahoma City Bombalı Saldırısından Cam Kırıkları

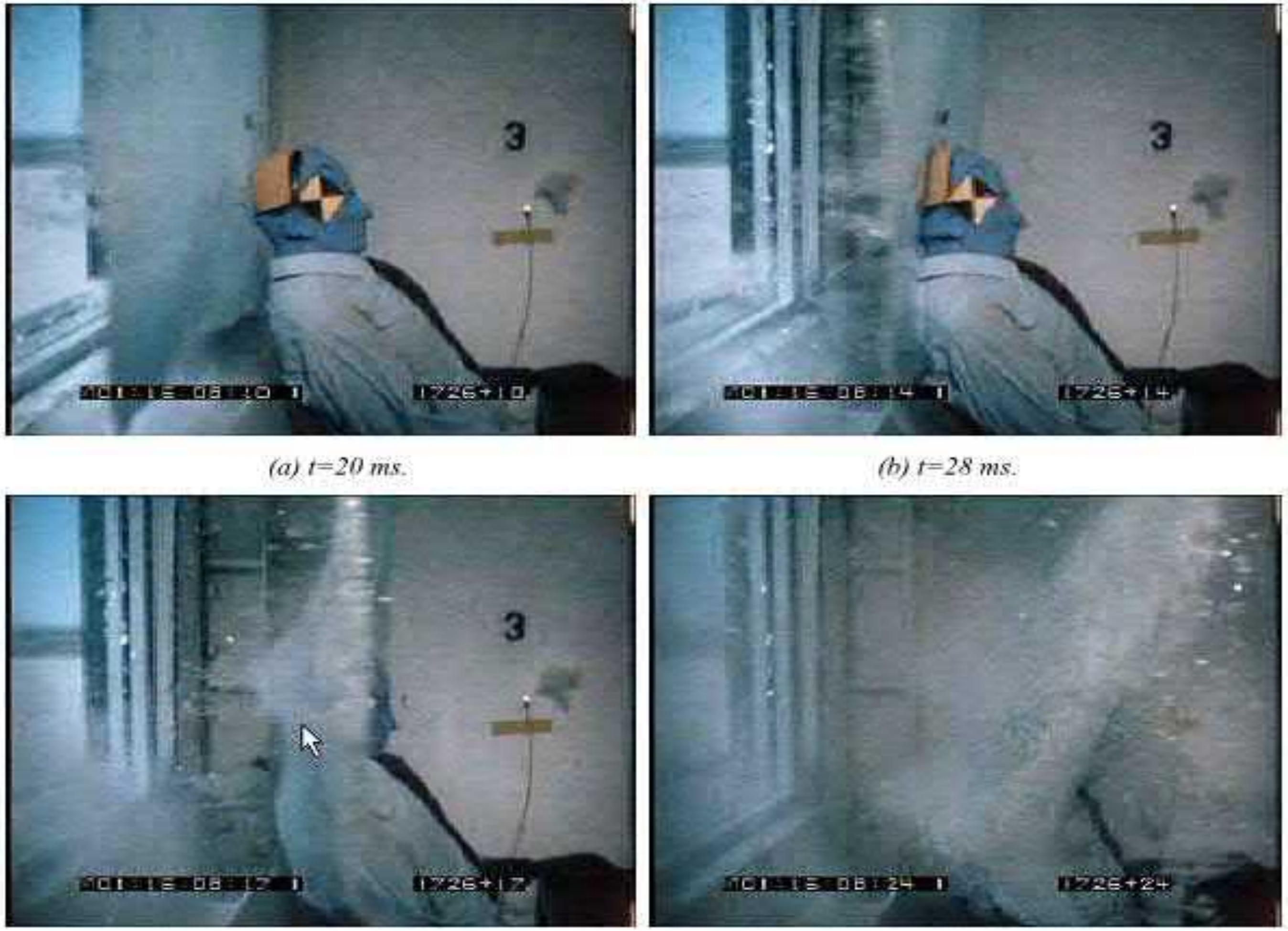
Oklahoma City Bombalı Saldırısından Cam Kırıkları



- The blast destroyed or damaged 324 buildings within a 4-block radius, and shattered glass in 258 nearby buildings.
- The broken glass alone accounted for 5 percent of the death total and 69 percent of the injuries outside the Murrah Federal Building.

Cam Davranışı

Camların Davranışı

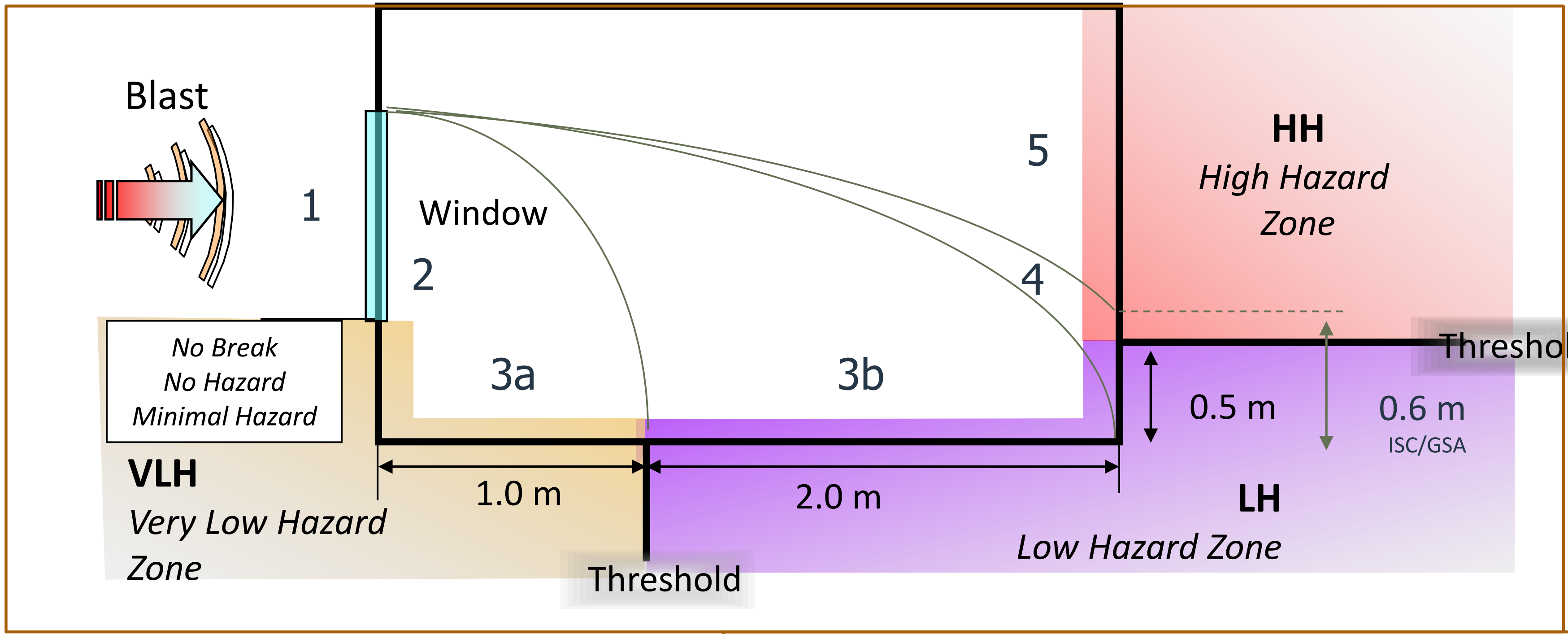


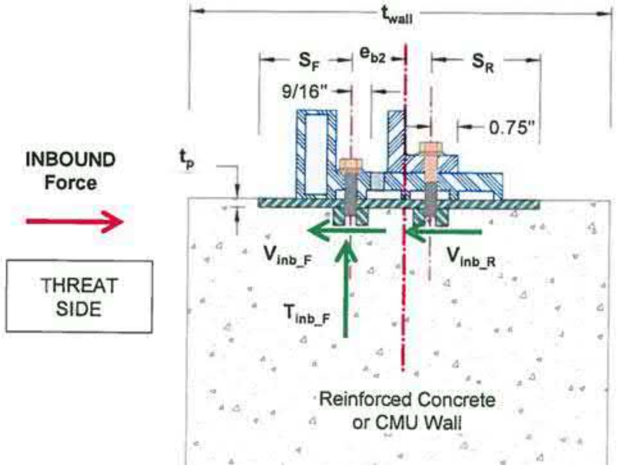
(a) t=20 ms. (b) t=28 ms.

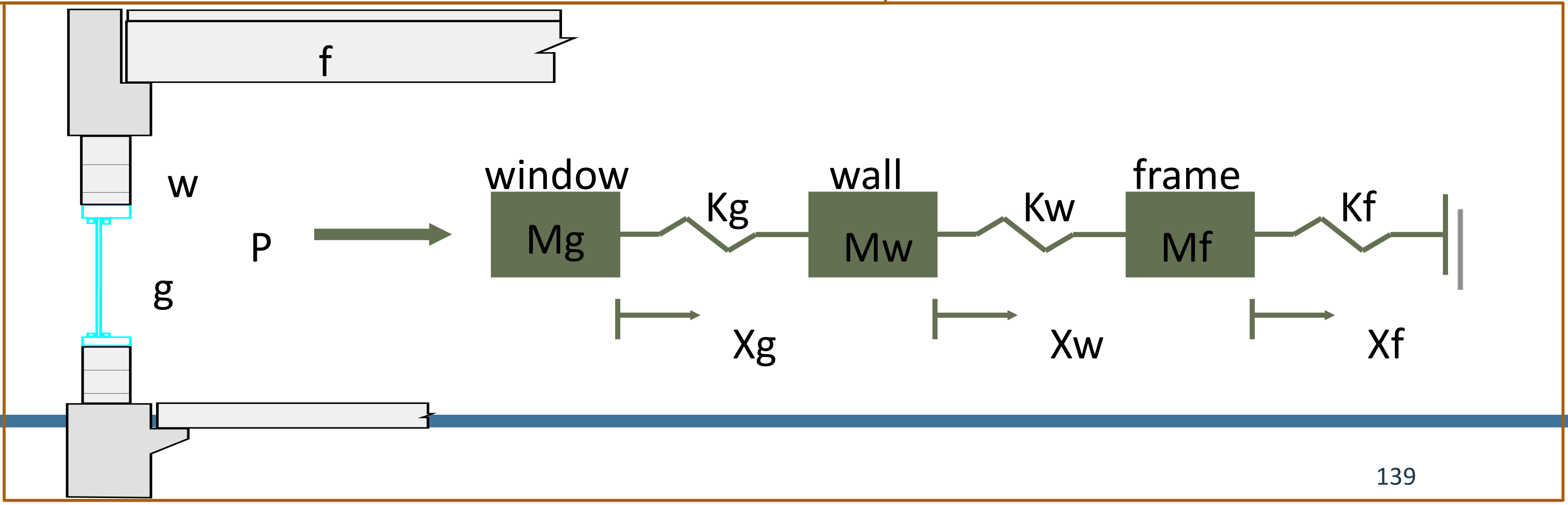
(c) t=34 ms. (d) t=49 ms.

Ref: Bogosian and Avenessian (2002), To Film or Not To Film: Effects of Anti-Shatter Film on Blunt Trauma Lethality From Tempered Glass, 17th International Symposium on Military Aspects of Blast and Shock

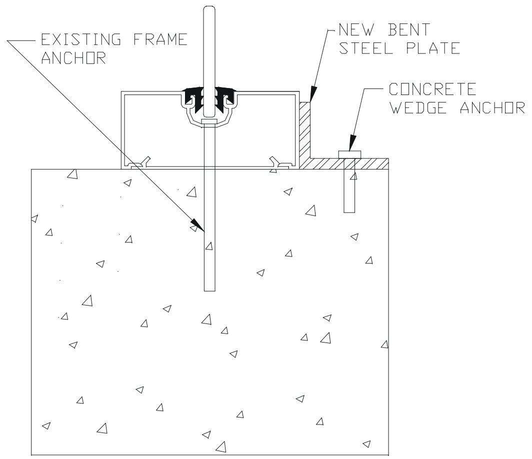
Cam – Çerçeve – Duvar Bağlantısı

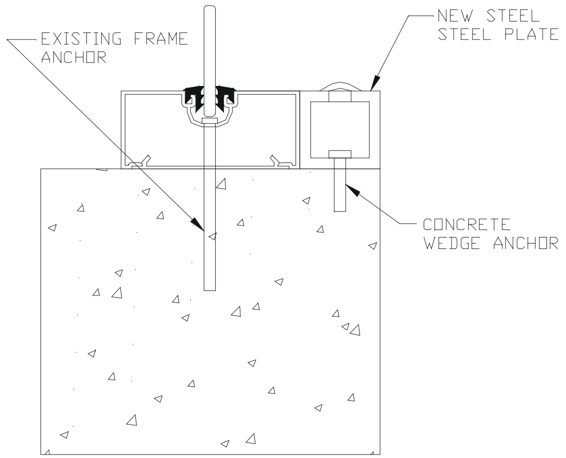


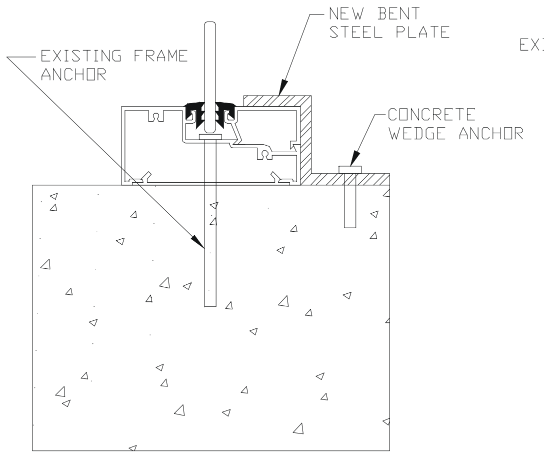


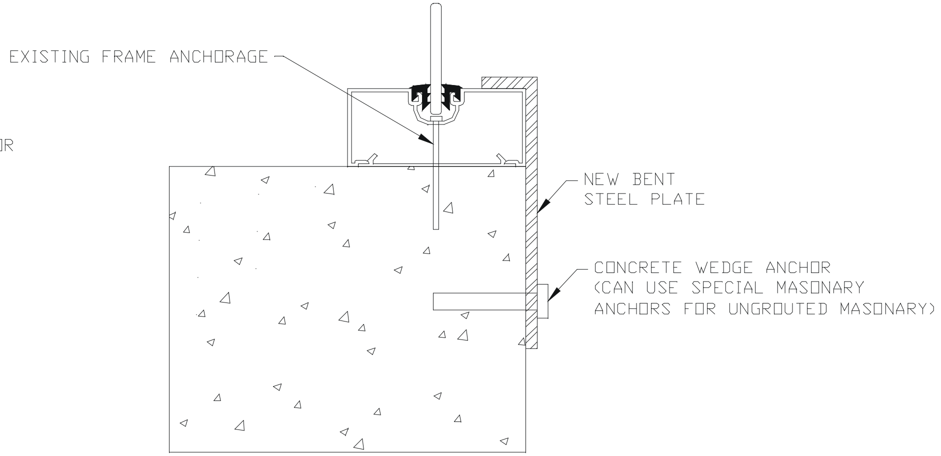


Cam Çerçevesi Duvar Bağlantıları

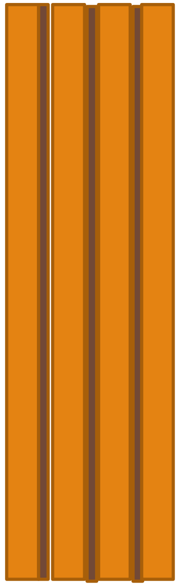




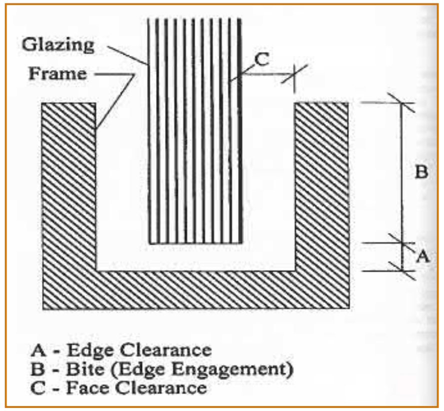




Camların Davranışı



Laminated Glass,
thickness = 1inch



Camların Davranışı

Catch systems
- Fabric Curtains
- Shield Panel
- Catching Bar
- Drapes
- Shades

Tempered Glass

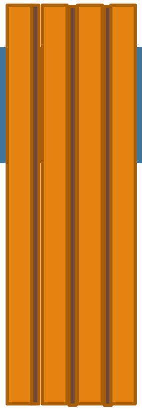
Laminated Glass

Polycarbonate Glass

Patching Window Opening

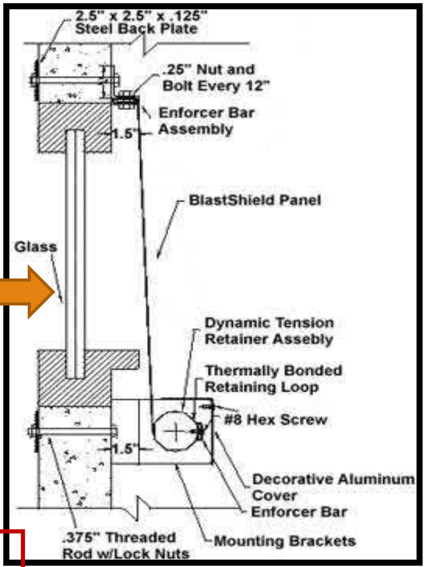
Security Film

Polycarbonate

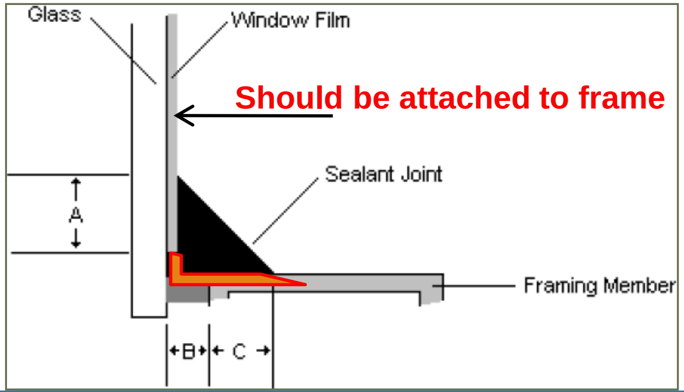


Laminated

Security Shades



Fabric curtains



Security Film

Camların Davranışı

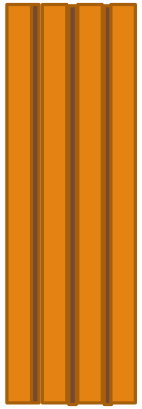
Catch systems

Laminated Glass

Polycarbonate Glass

Patching Window Opening

Security Film



Laminated

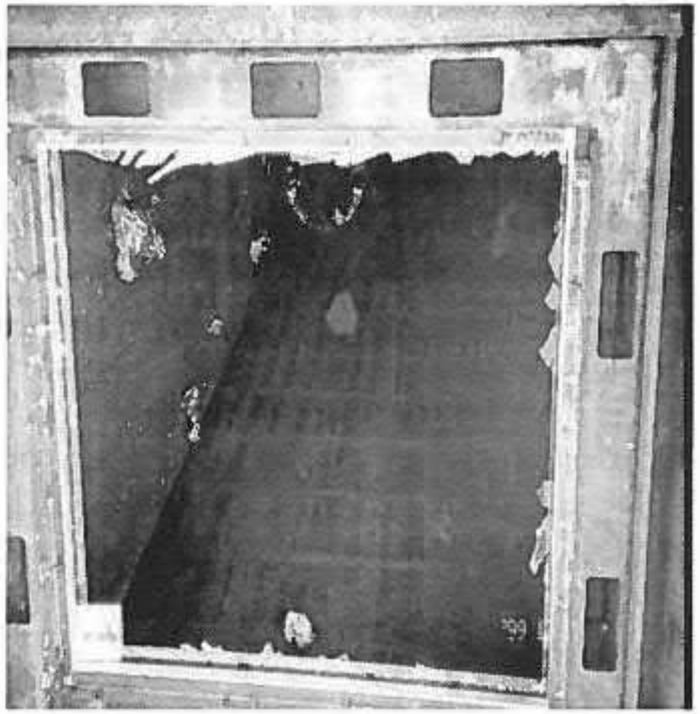
Fabric curtains

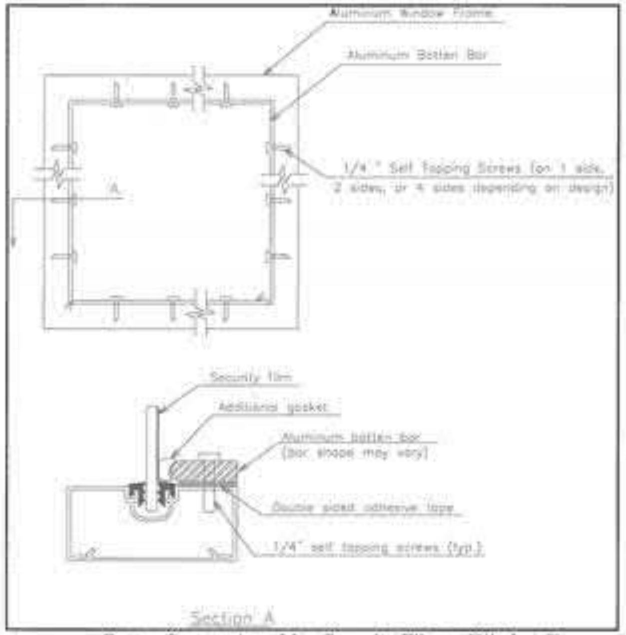
Security Film

Madico SafetyShield

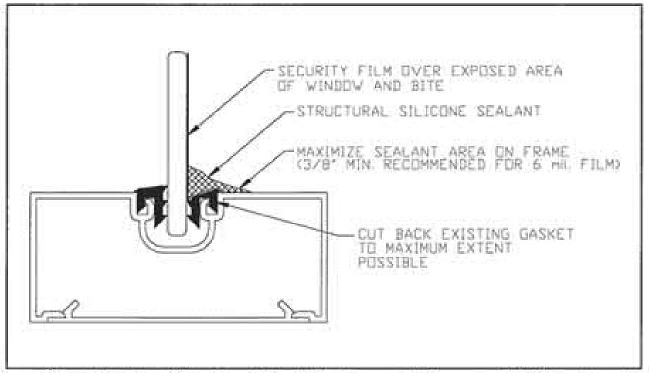
Camların Davranışı – Güvenlik Filmi

Camların Davranışı – Güvenlik Filmi





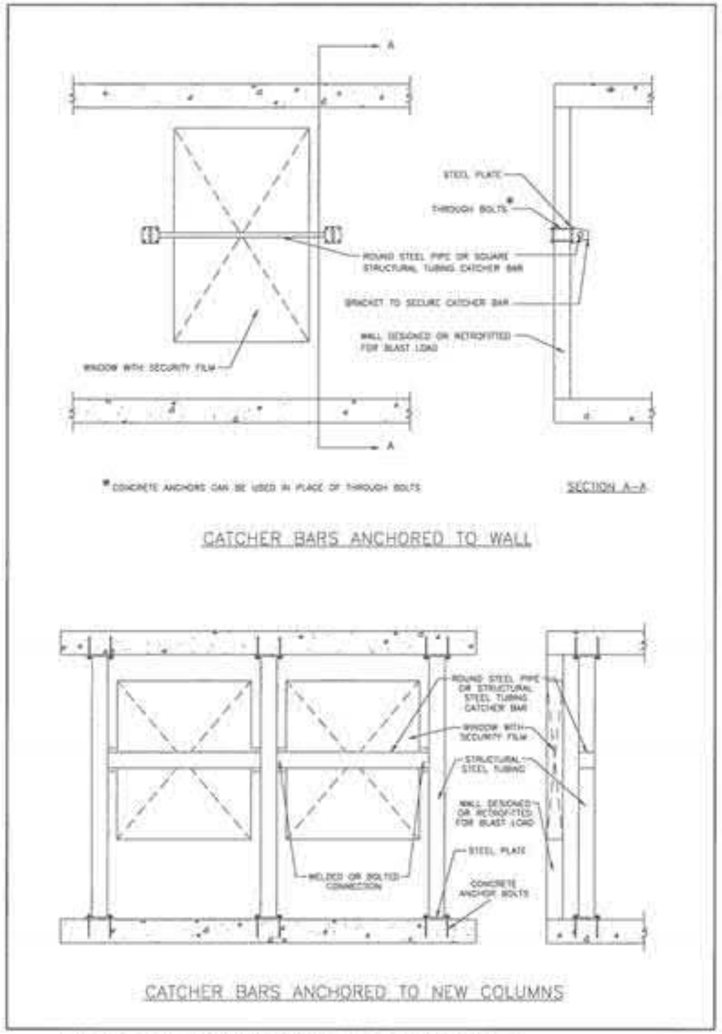
Batten System Attaching Security Film to Window Frame



Cross Section Showing Film Attachment to Frame with Structural Silicone

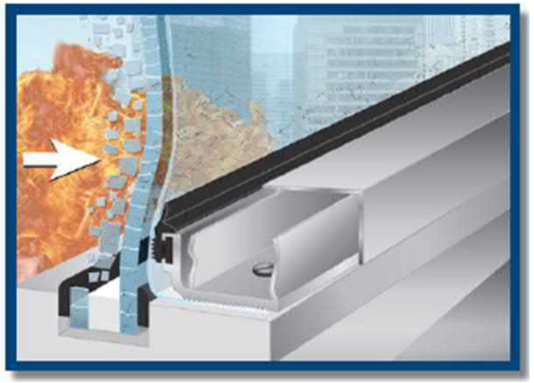
Camların Davranışı – Güçlendirme Yöntemleri

Catcher Bar Holding Filmed Glass After Blast Load



Anchorage of Catch Bar System to Building

Patlama Kalkanı

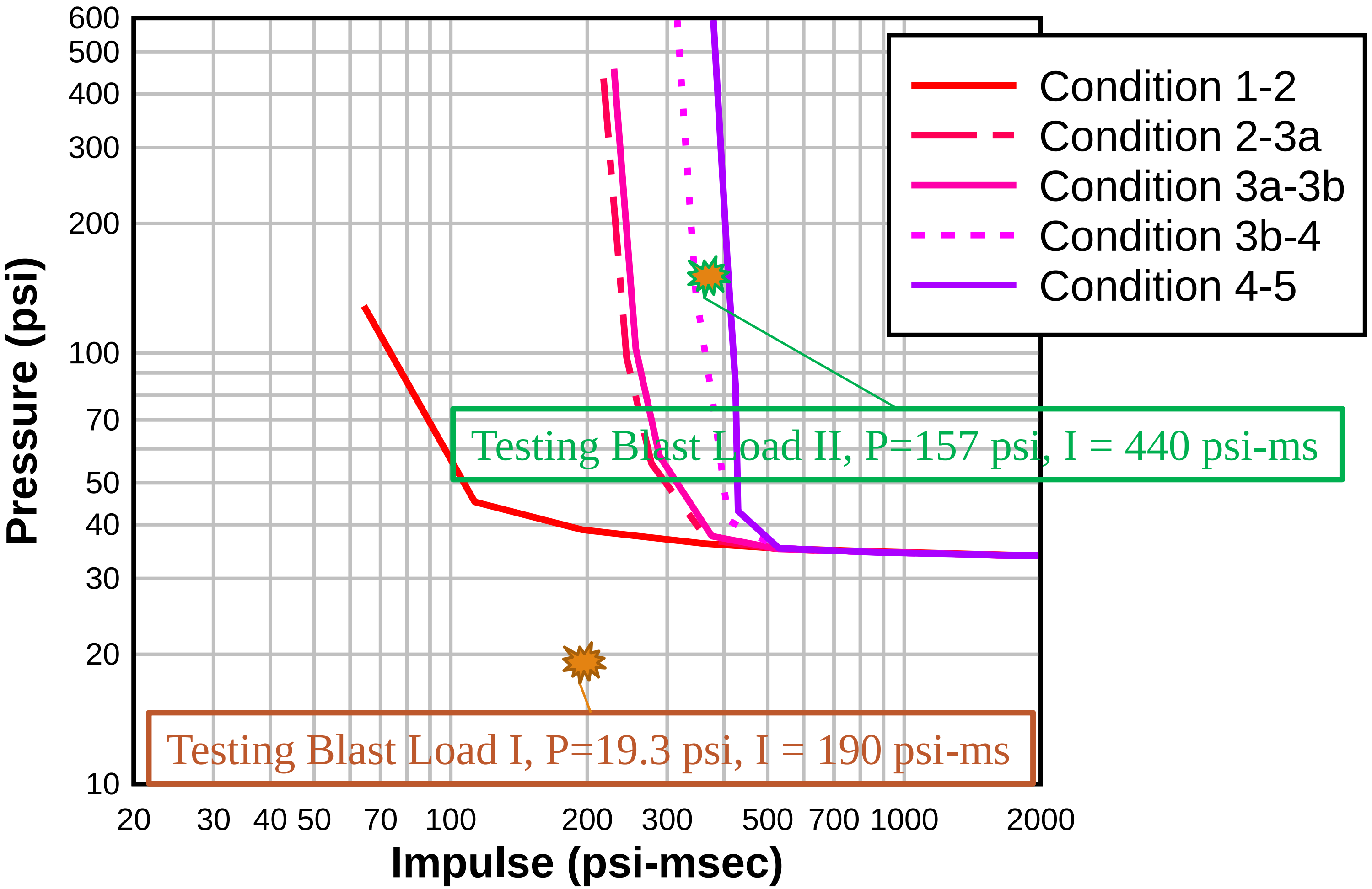


Patlama Perdesi

Patlama Testleri – Ağustos 2020 – Cam Sonuçları

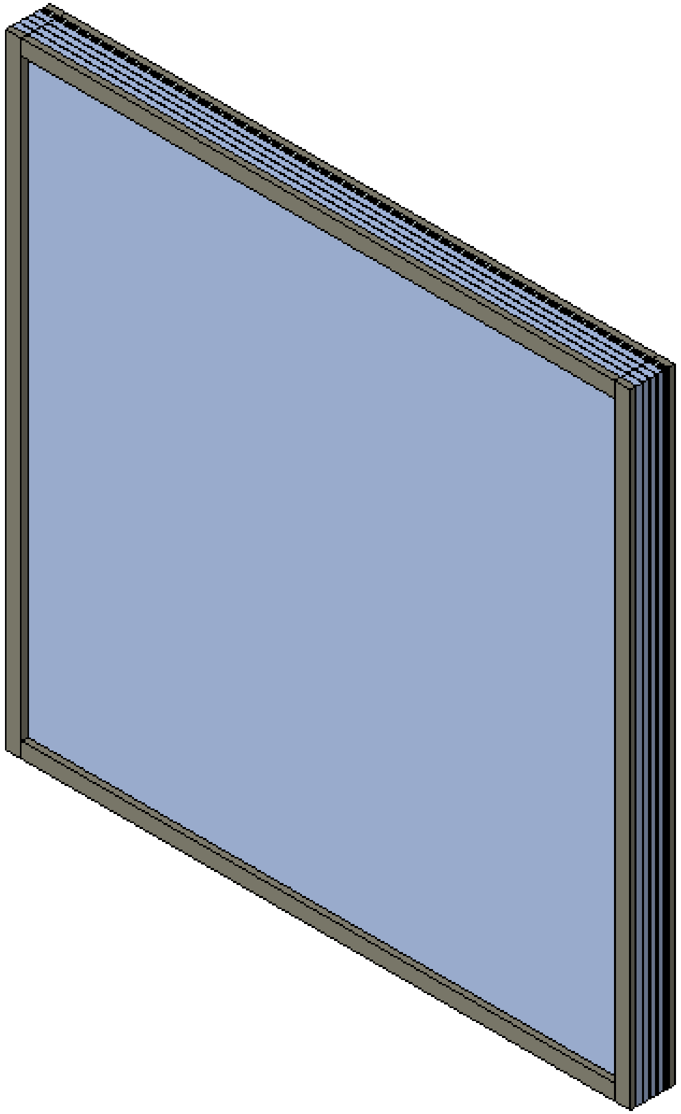
After test 1

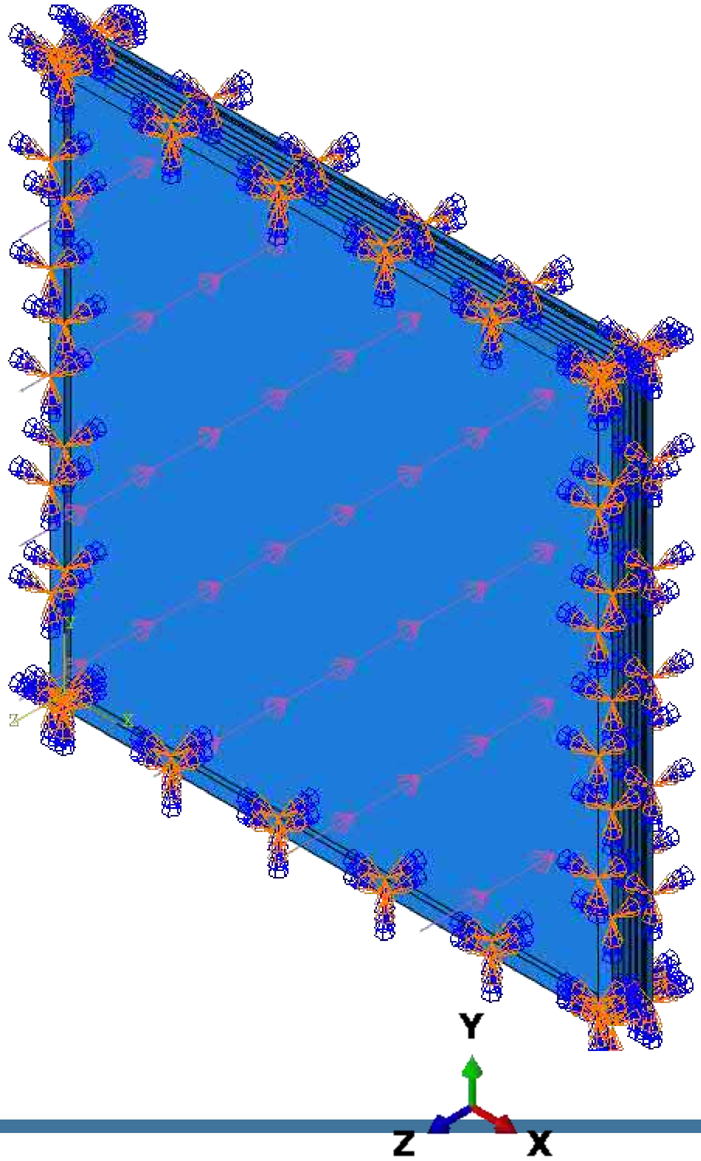
After test 2

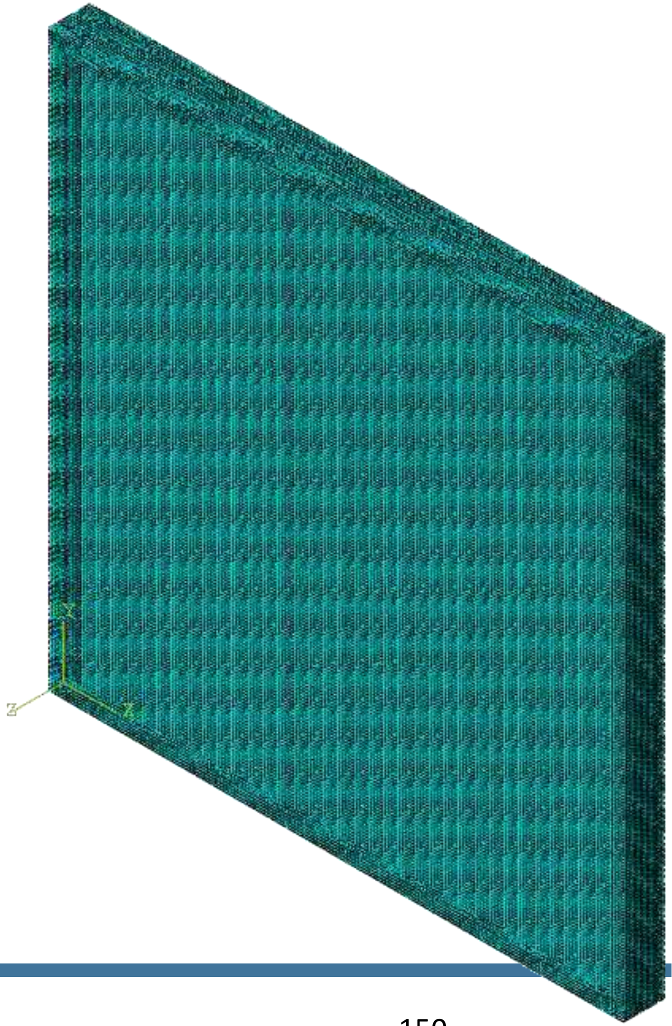


Numerical modeling and validation

FEM Models 11-layers LG





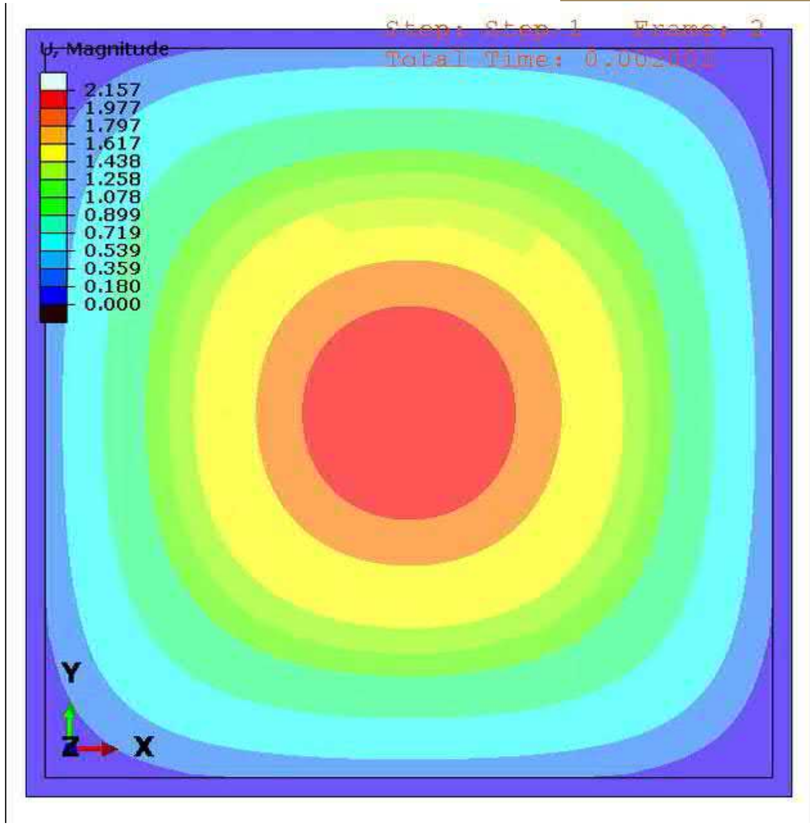


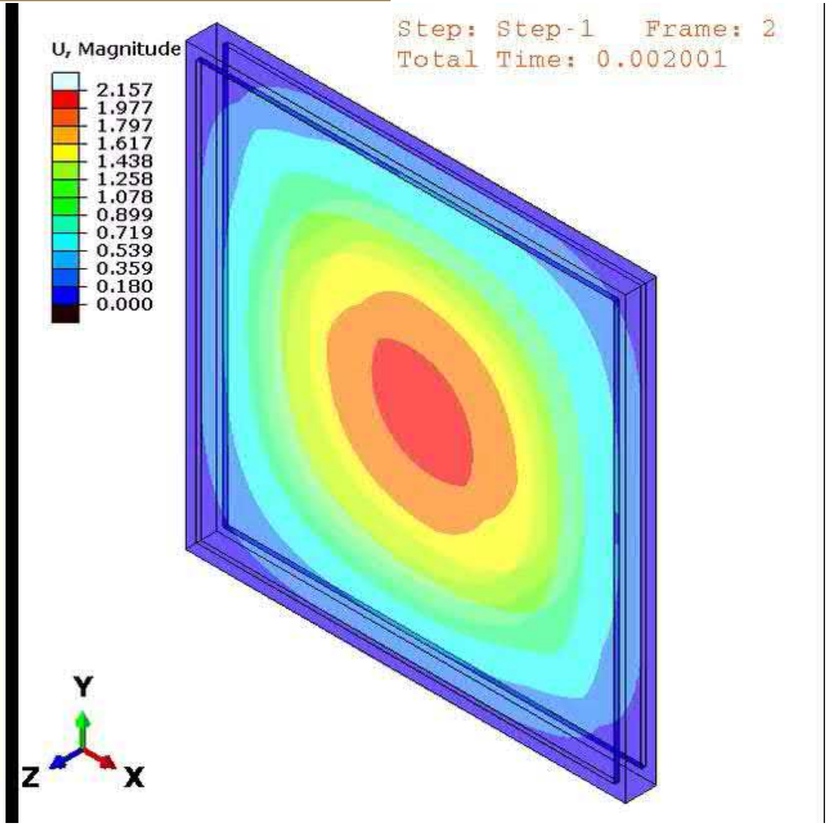
Numerical modeling and validation

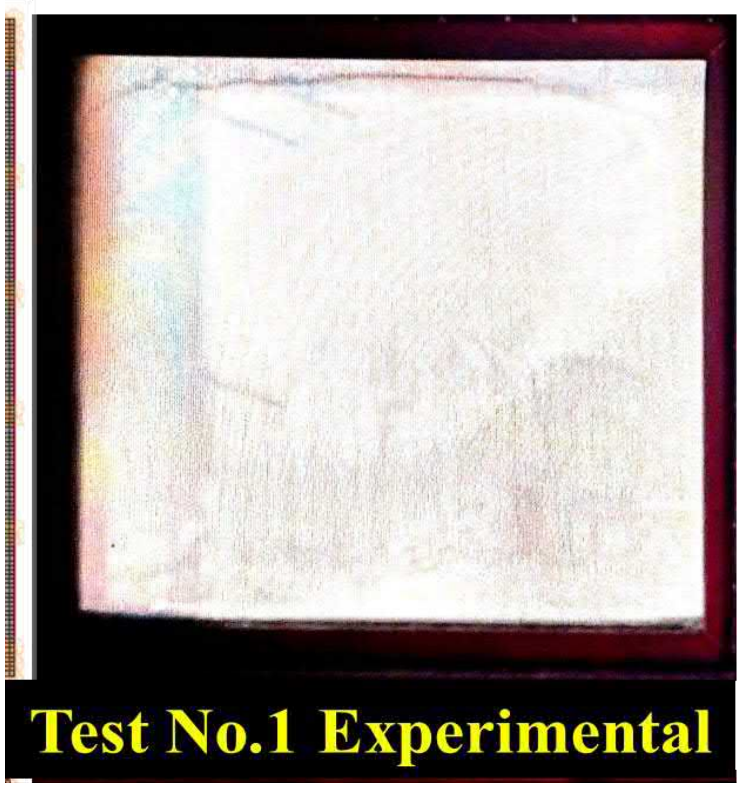
Model validation 11 layer Test1

- The laminated glass model for 11 layers matches the expected no cracking in the RedGuard Test-1.

FEM-SPH : Displacement (mm)





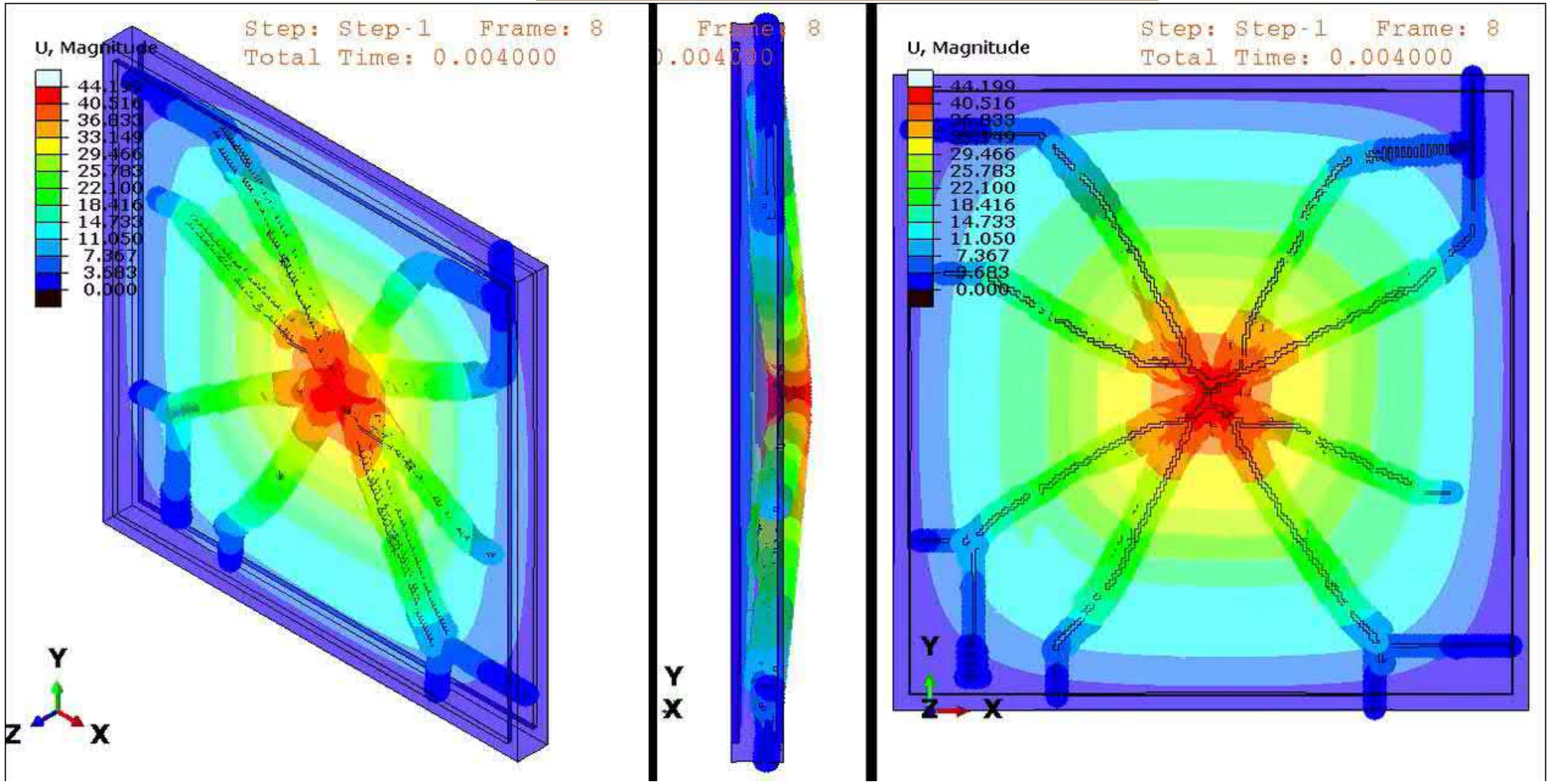


Numerical modeling and validation

Model validation 11 layer Test2

- The laminated glass model for 11 layers matches the expected cracking pattern in the RedGuard Test-2.

FEM-SPH : Displacement (mm)

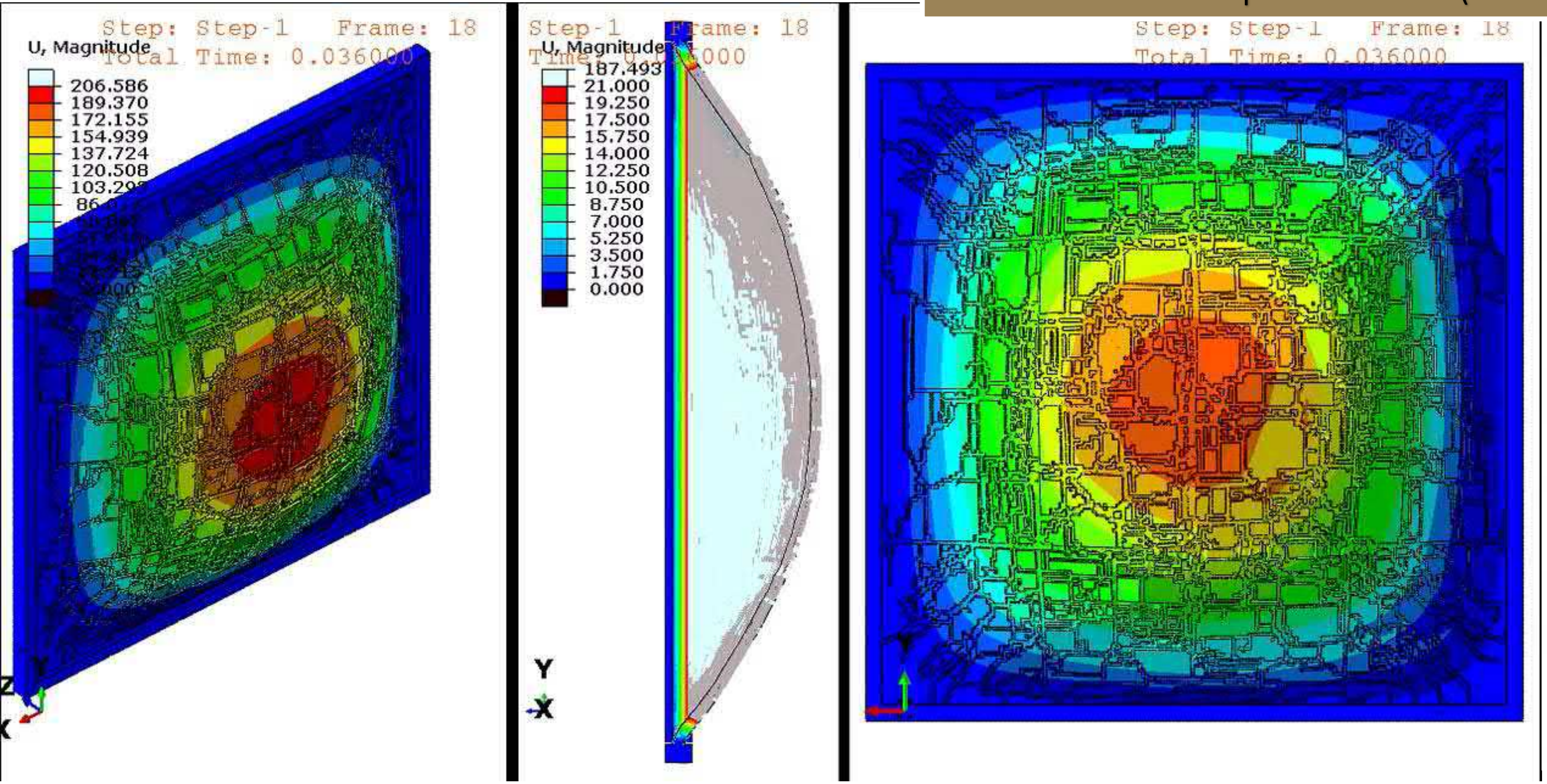


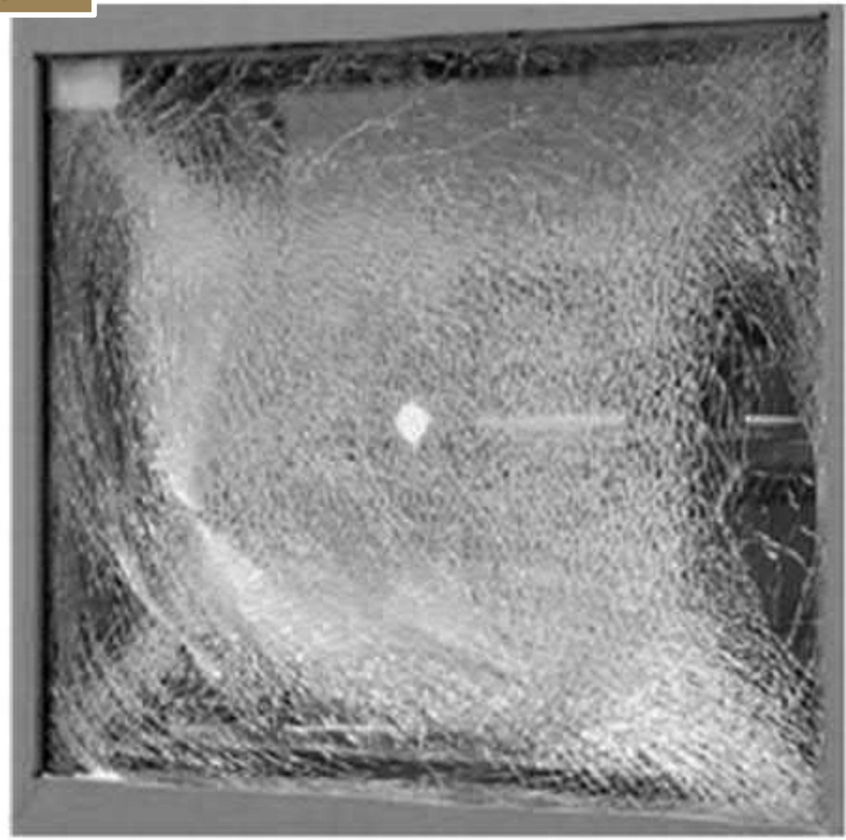
Test No.2 Experimental

Numerical modeling and validation

FEM Models: EXP-8 run

FEM-ED : Displacement (mm)





EXP-8 Kranzer

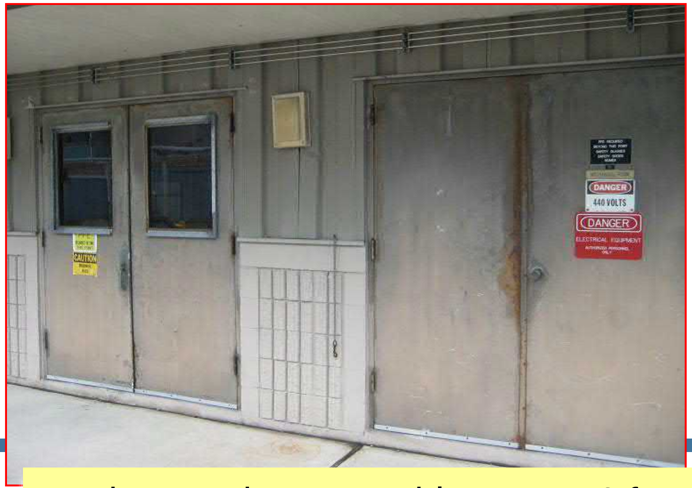
Patlamaya Dayanıklı Kapılar

Kapılar

Blast Resistant Door

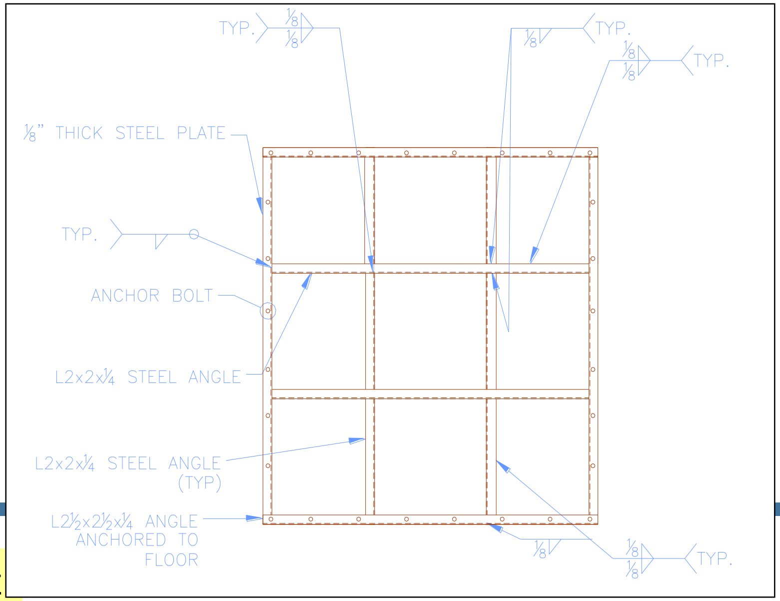
Damage Level	Damage Description	Blast Pressure* (psi)
Superficial	Operable, No Permanent Deformation	***~0.3***
Minor	Operable with Force, Slight Permanent Deformation	***0.5***
Medium	Operable with Hardware removed, Significant Permanent Deformation	***1.0***
Severe	Door Panel Wedged in Frame, Heavy Damage	***1.5***
Failure	Panel dislodged from frame, Debris hazard	***2.5***

* by experience

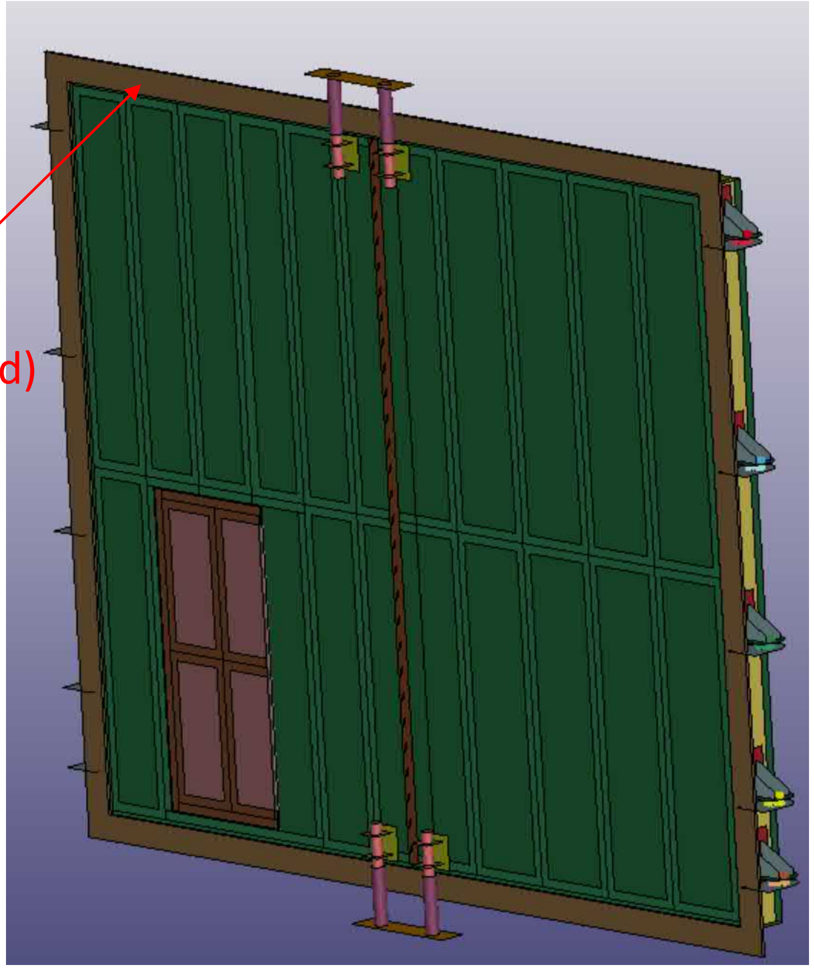


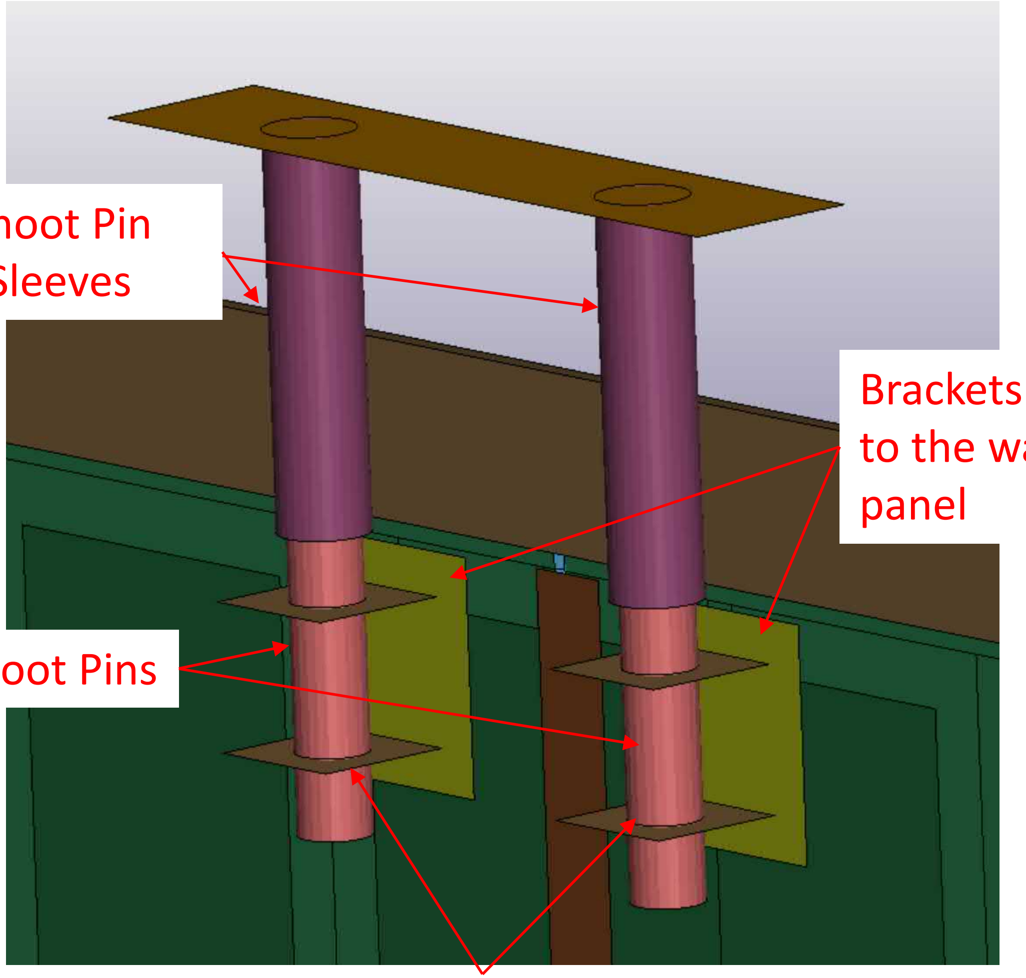
Equipment door – Double Door – 6 ftx7 ft

Single door - 3 ftx7 ft



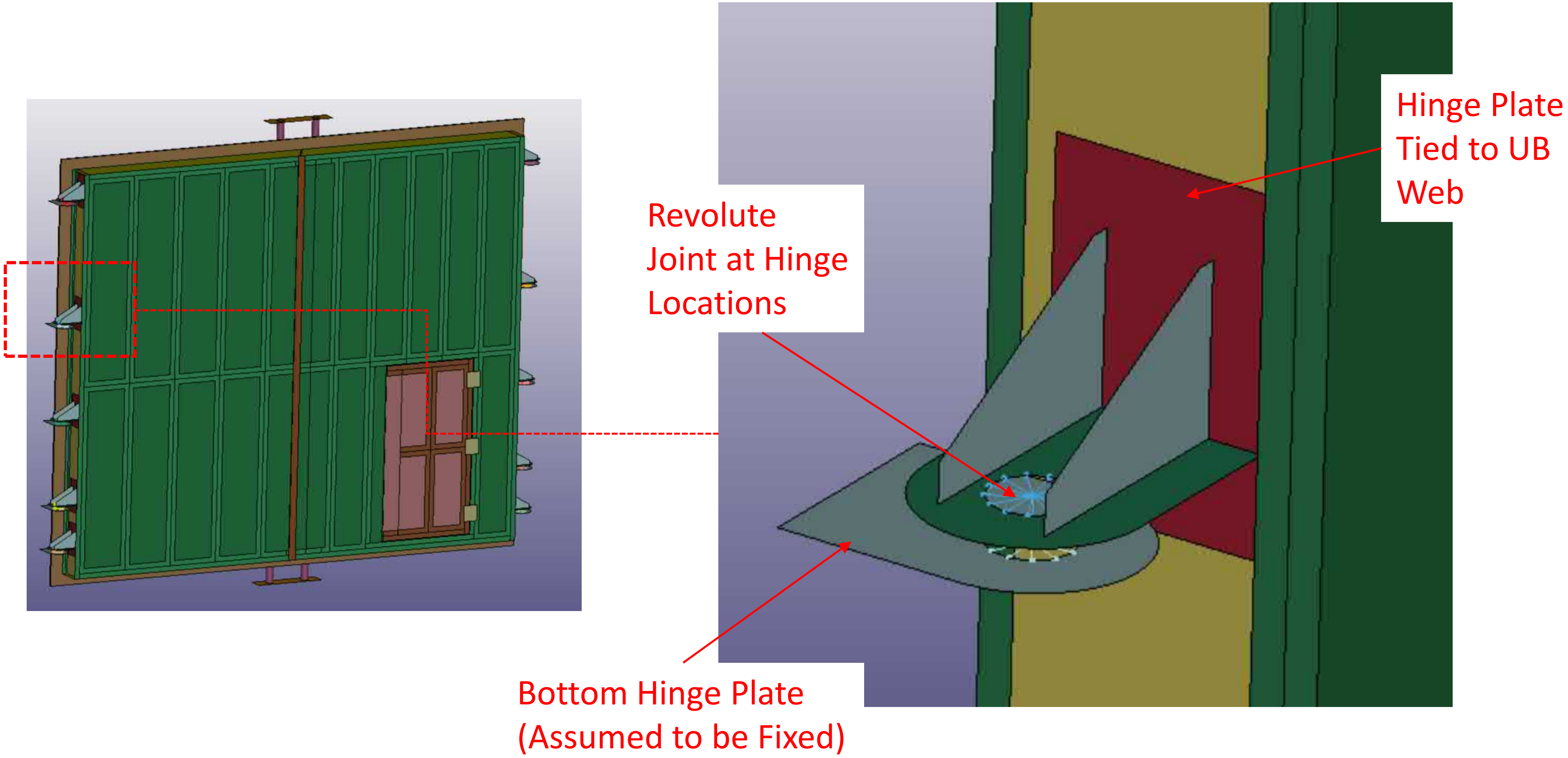
FE Model Overview





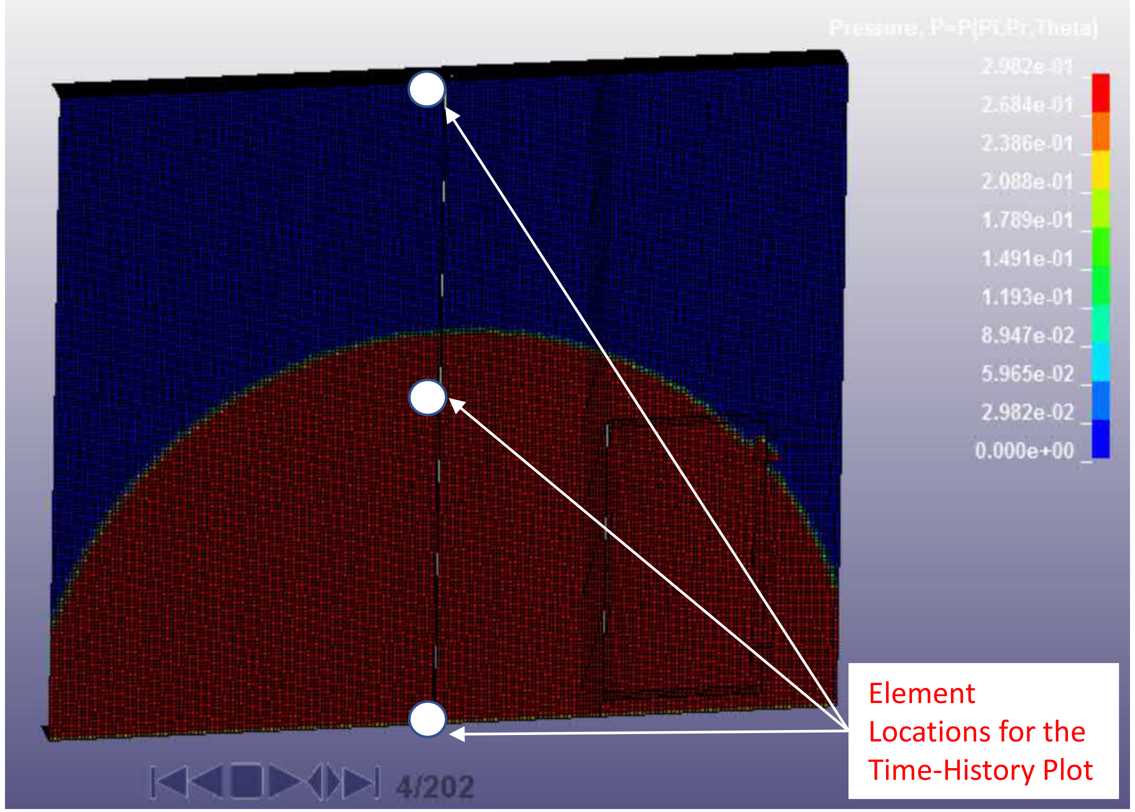
Shoot Pins are assumed to be connected to the brackets with the guide plates

FE Model Overview

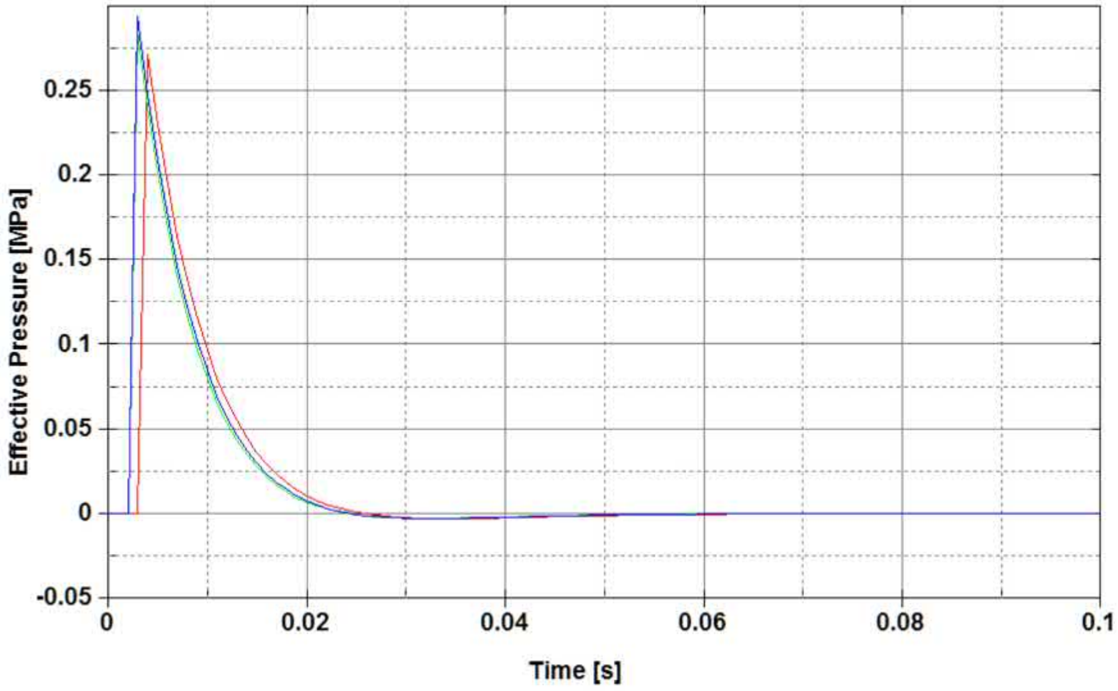


Blast Load – 900 lbs TNT

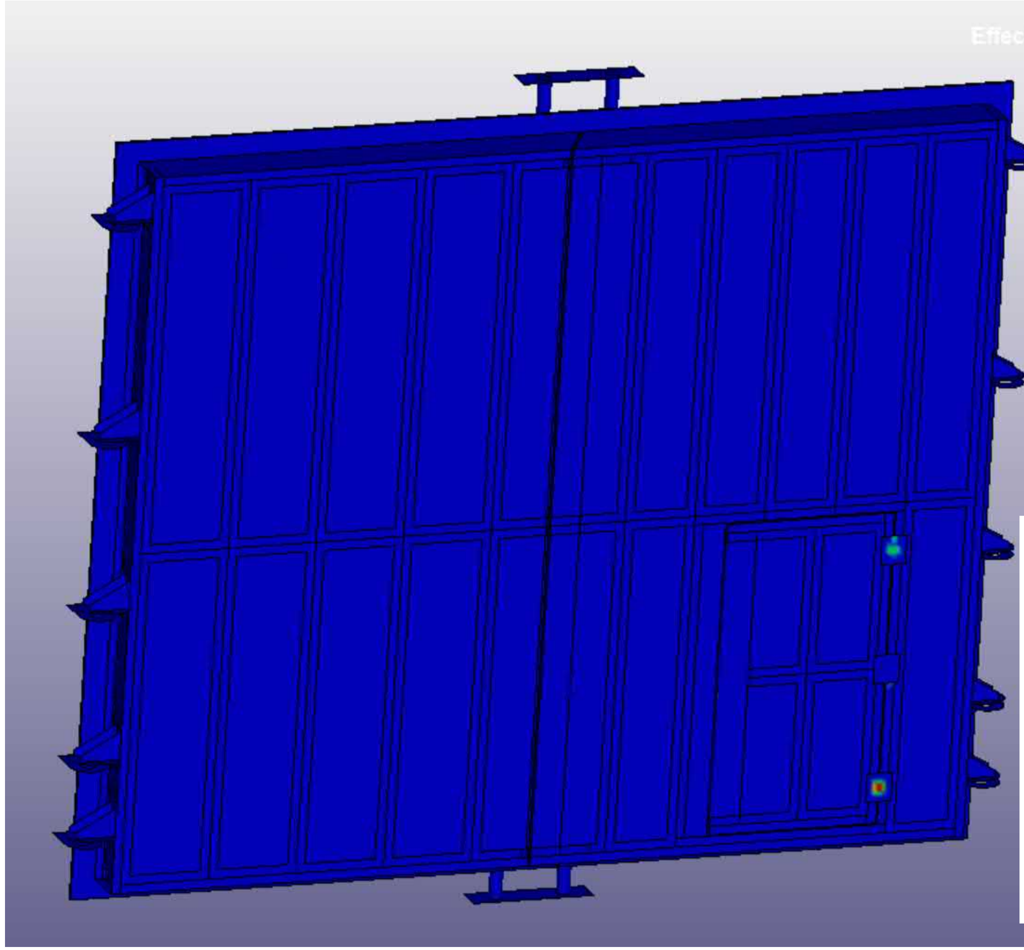
Eff. Blast Load on the Blast Door @ t = 4 ms



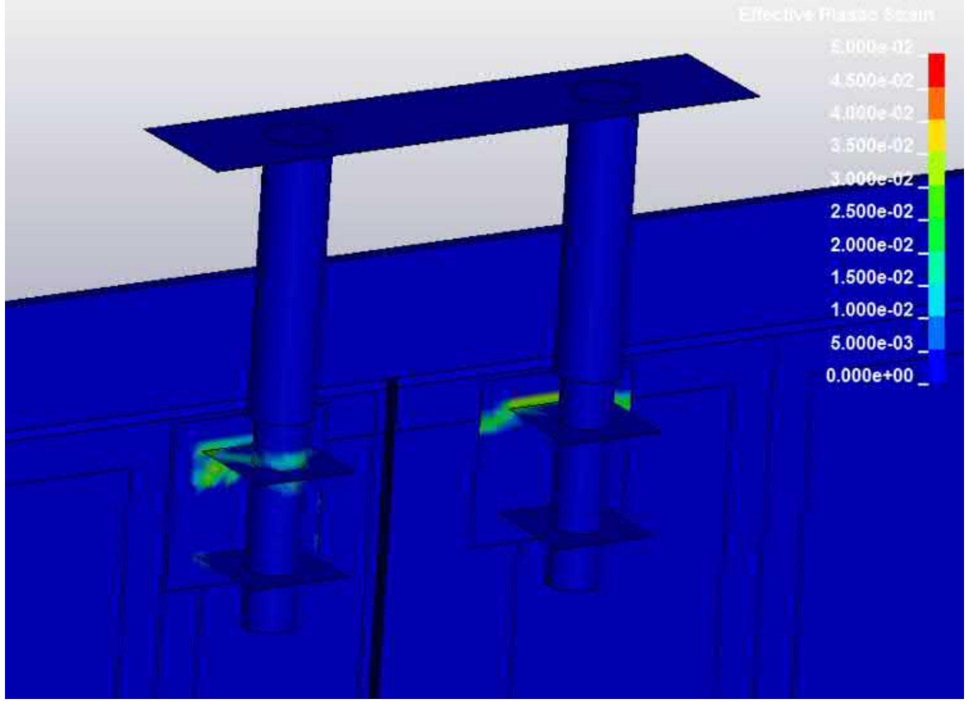
Eff. Pressure Time History for 3 Selected Nodes

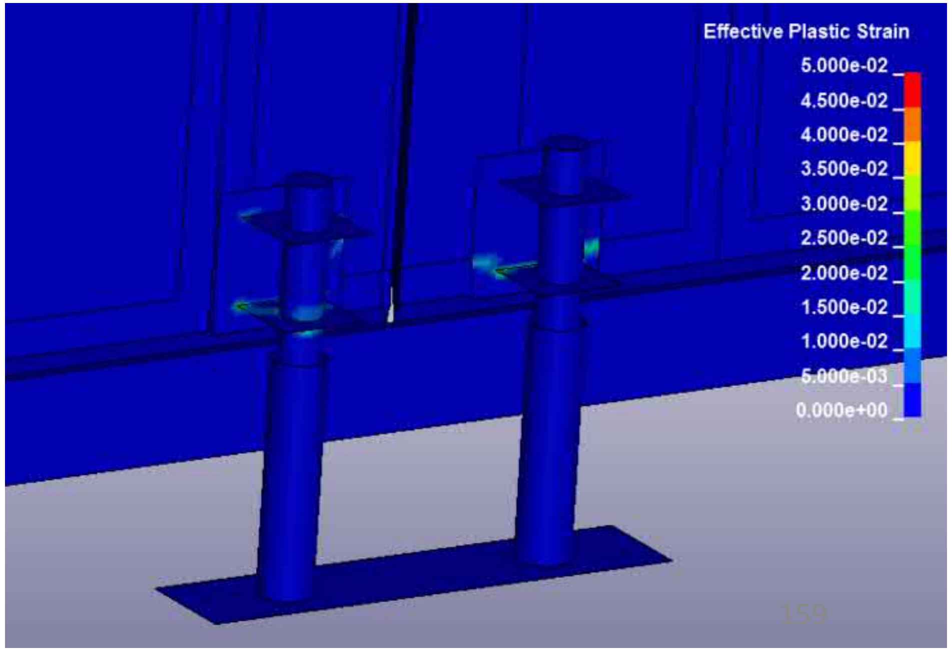


Eff. Plastic Strain Contours



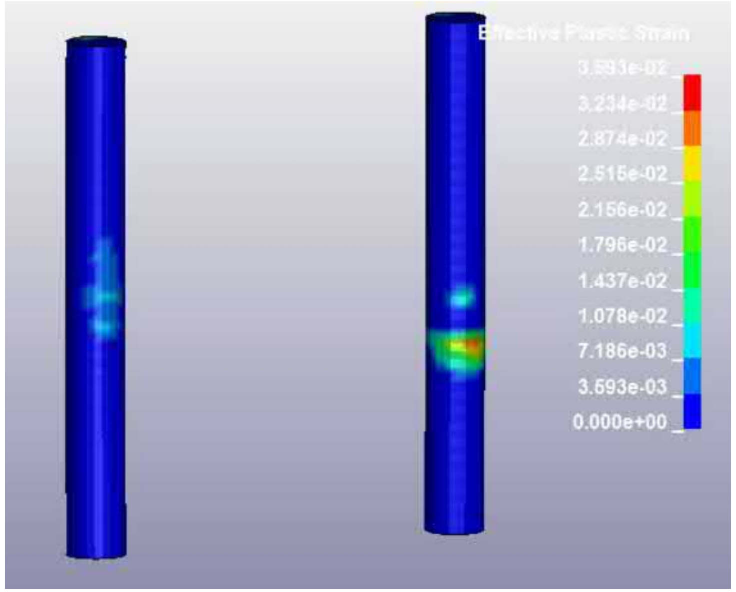
Localized strains at wicket door hinges and shoot pin locations / Neglected due to modeling assumptions



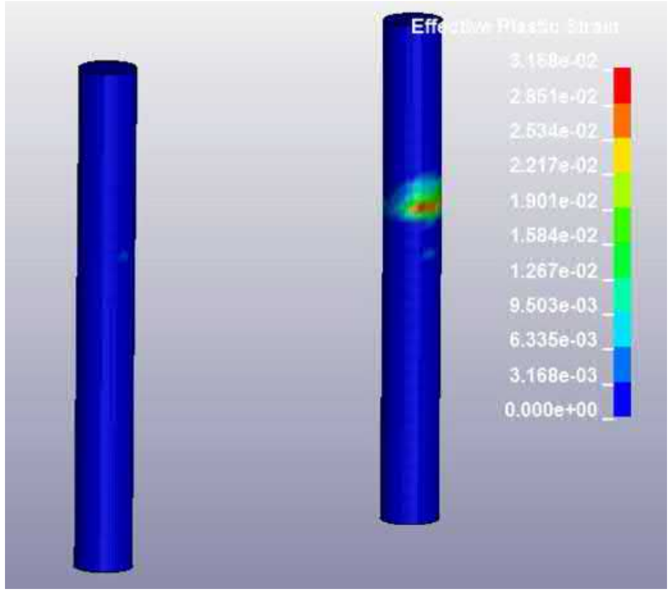


Eff. Plastic Strain Contours

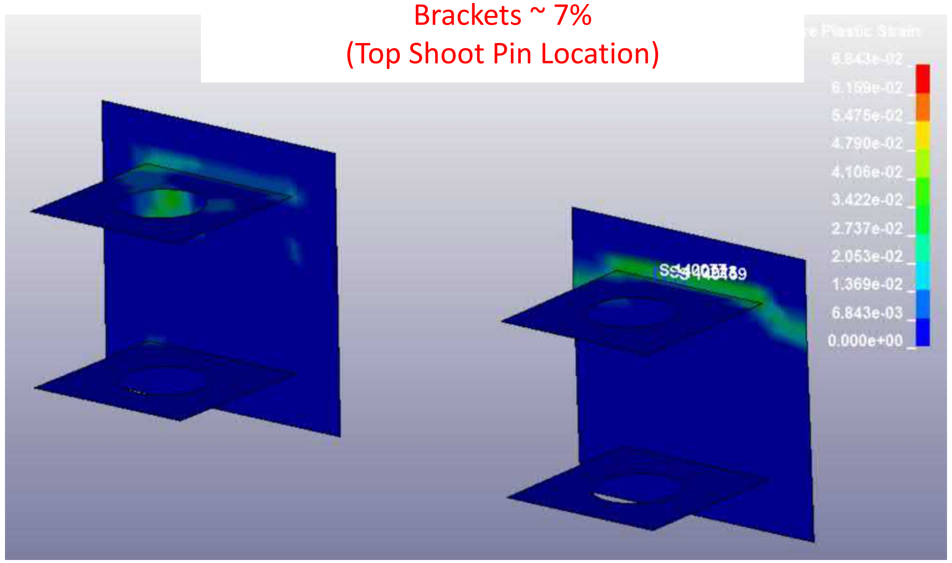
Max. Eff. Plastic Strain for Top Shoot Pins ~ 3.6%

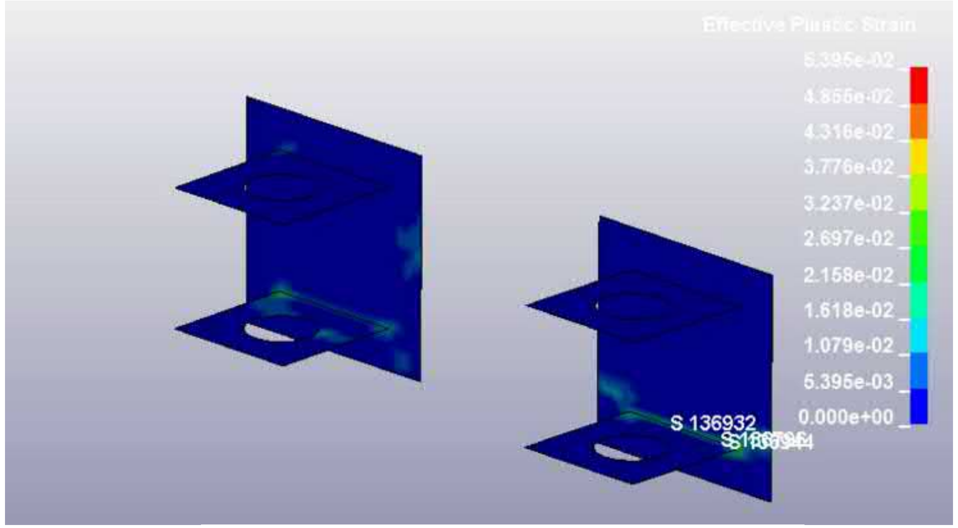


Max. Eff. Plastic Strain for Bottom Shoot Pins ~ 3.2%



Max. Eff. Plastic Strain for Shoot Pin Brackets ~ 7%
(Top Shoot Pin Location)





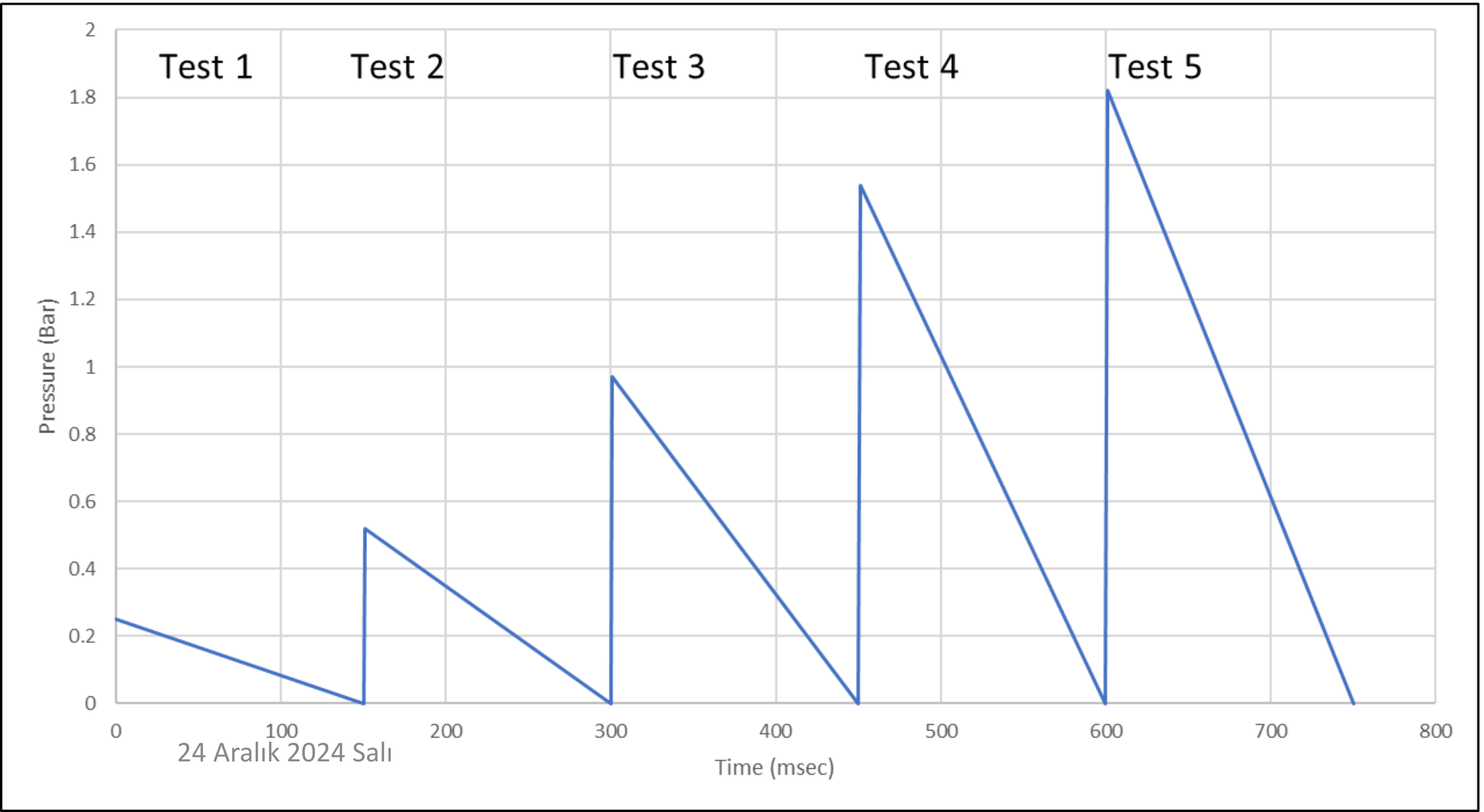
Max. Eff. Plastic Strain for Shoot Pin Brackets ~ 5.4%
(Bottom Shoot Pin Location)

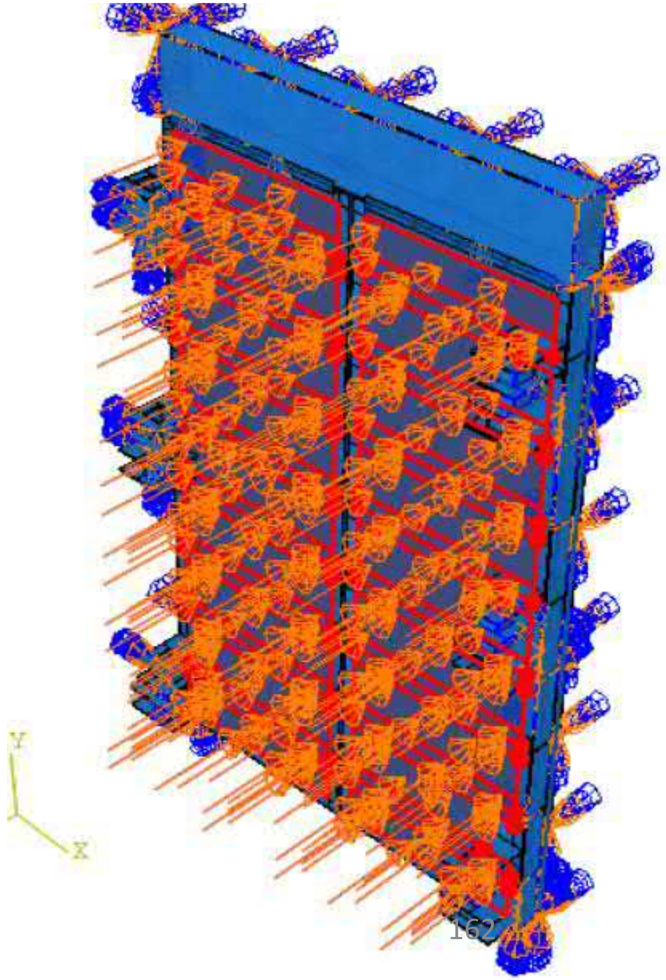
Blast Door Installed at the Closed Blast Testing Facility

VIDEO

Loads definition

The blast door was modelled and the five testing loads were applied

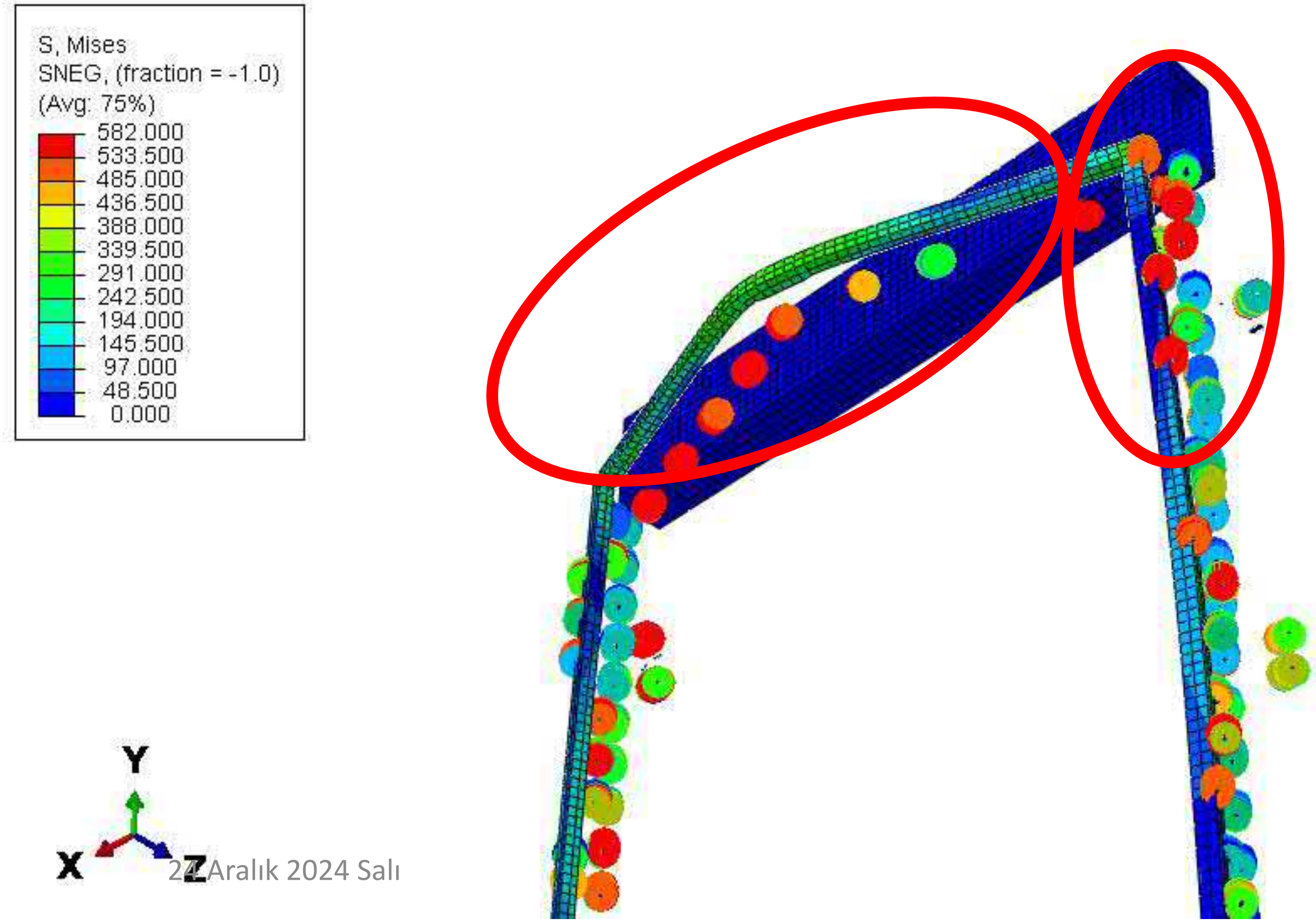




External view after test No. 5 with 3 kg TNT

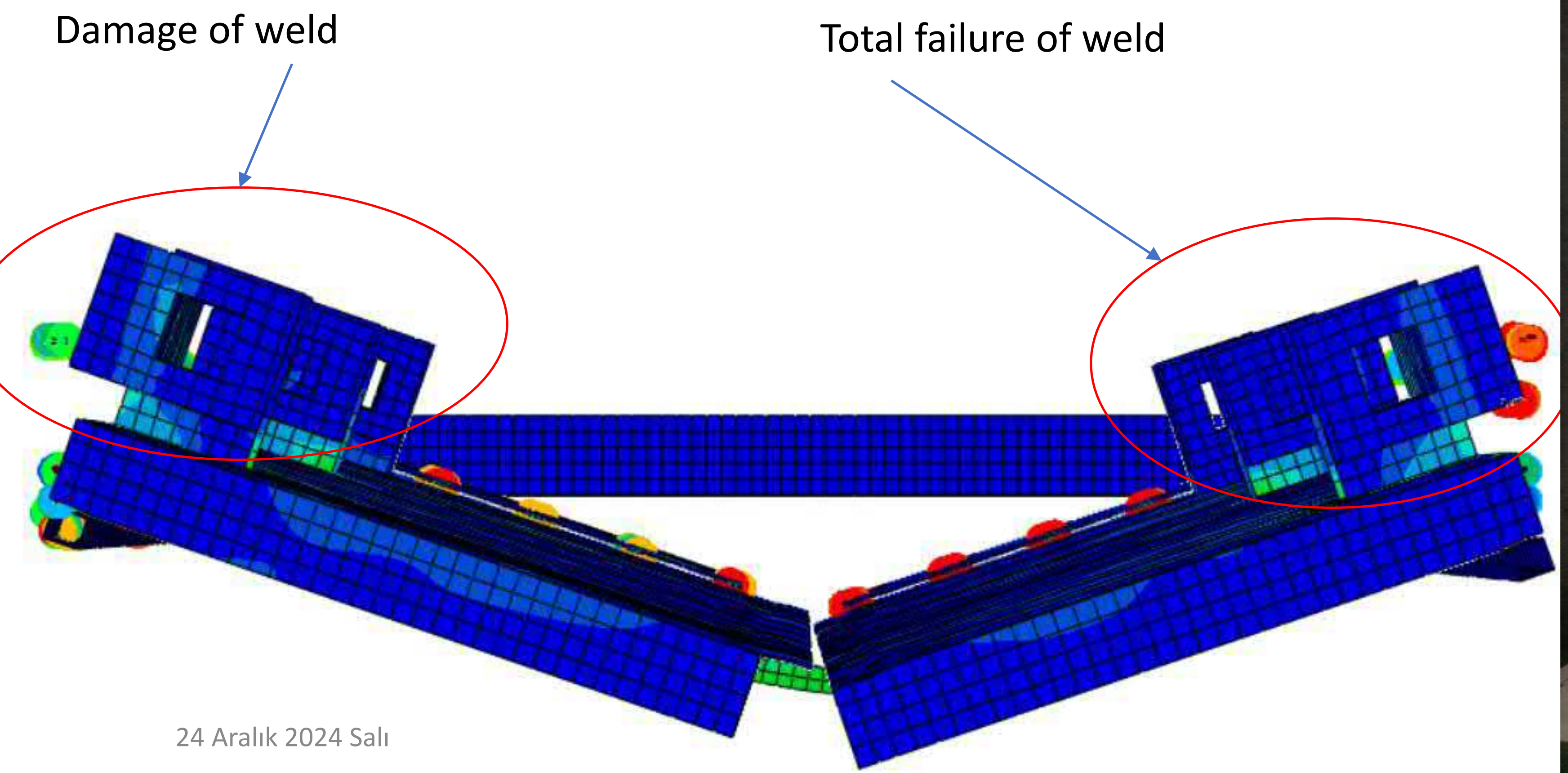
Results and Validation of Analysis Approach against Test Data

Test 5 resulted in plastic bending of the upper support and the weld failure at the top corner and detachment of the side support



Results and Validation of Analysis Approach against Test Data

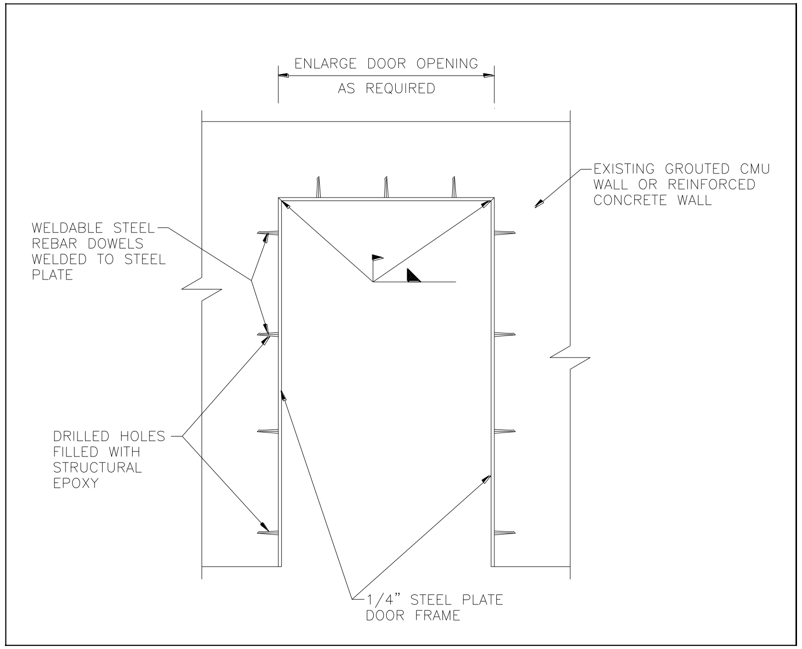
Test 5 resulted in the failure of the weld in one door leaf which resulted in its fall. The second leaf suffered weld damage without total failure



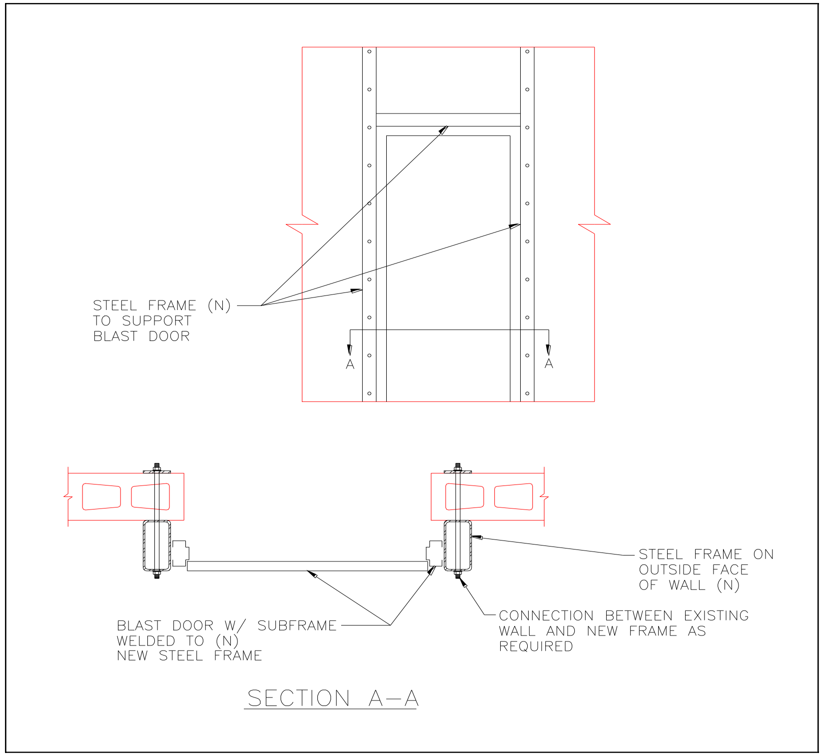
Kapı Hasar Seviyeleri

Damage Level	Overall Door System	Door Panel	Hardware
Elastic	Operable	No permanent deformation	Operable
Minor	Operable w/moderate force	Slight permanent deformation	Operable
Moderate	Operable w/hardware removed, door may be wedged in frame	Significant permanent deformation, door may be wedged in frame 1”-3”	Not operable
Severe	Panel wedged in frame	Substantial damage, door wedged into frame >3”	Heavily damaged
Failure	Panel dislodged from frame	Debris hazard	Heavily damaged

Patlama Kapısı Duvar Bağlantıları



Blast door attachment to grouted masonry or reinforced concrete wall

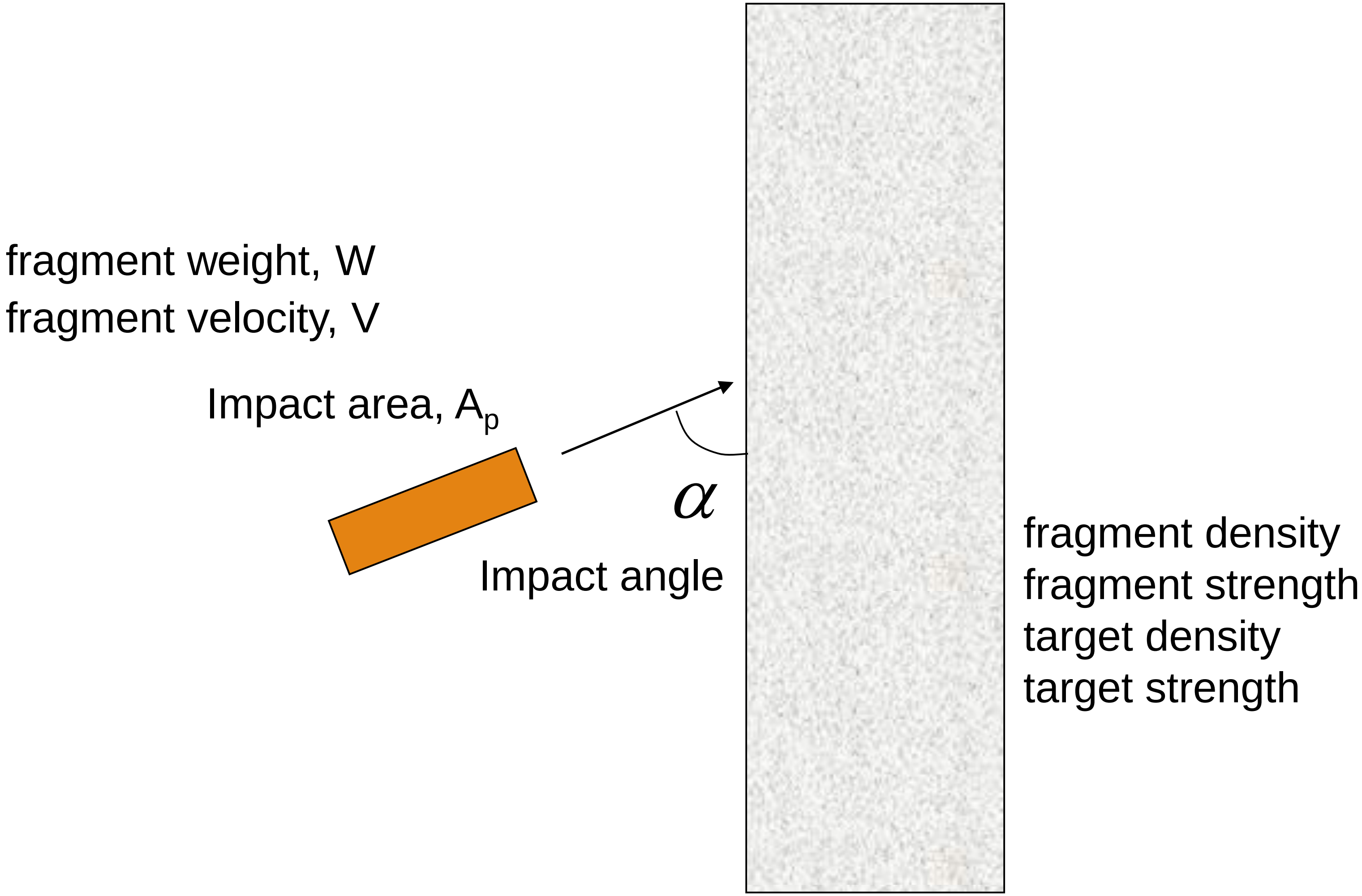


Blast door attachment to new steel frame support

Parçacık Etkisi – Fragments and Debris

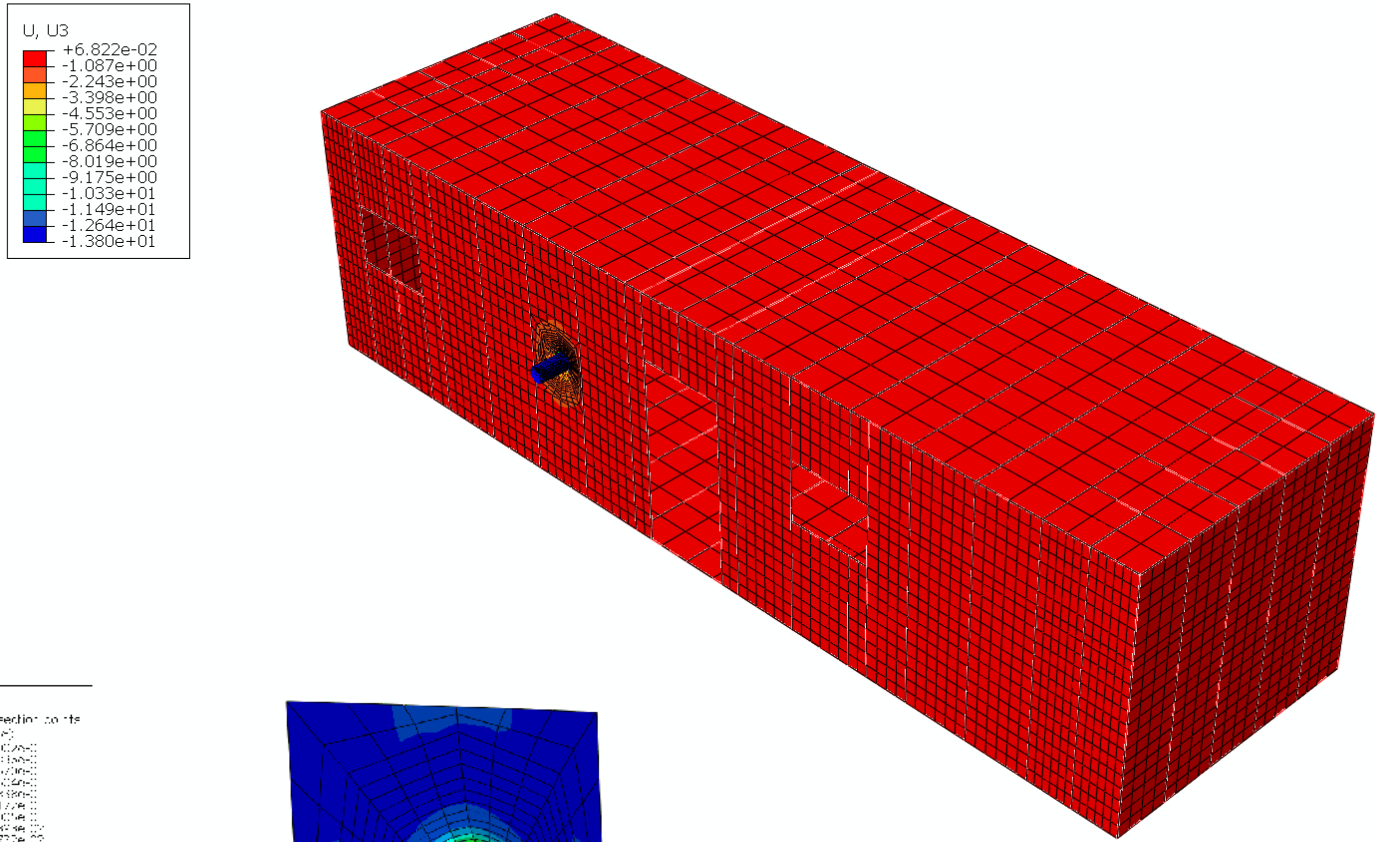
Parçacıklar

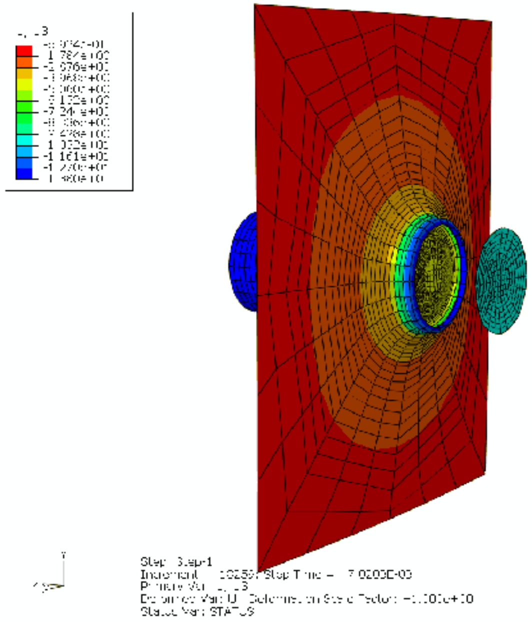
Parçacık Penetrasyonu

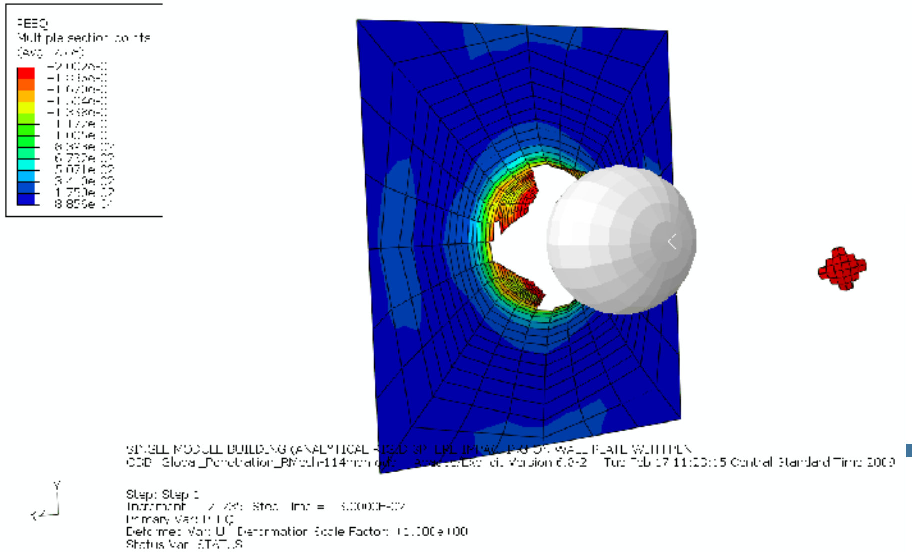


Parçacık Çarpması

- A deformable Fire Extinguisher (or rigid sphere) is penetrating a Wall Panel
- Estimate the minimum projectile velocity required to perforate the flat plate walls of a typical modular blast-resistant typical building

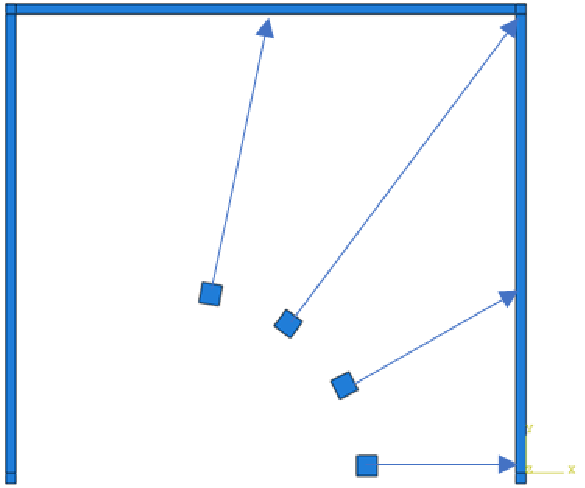


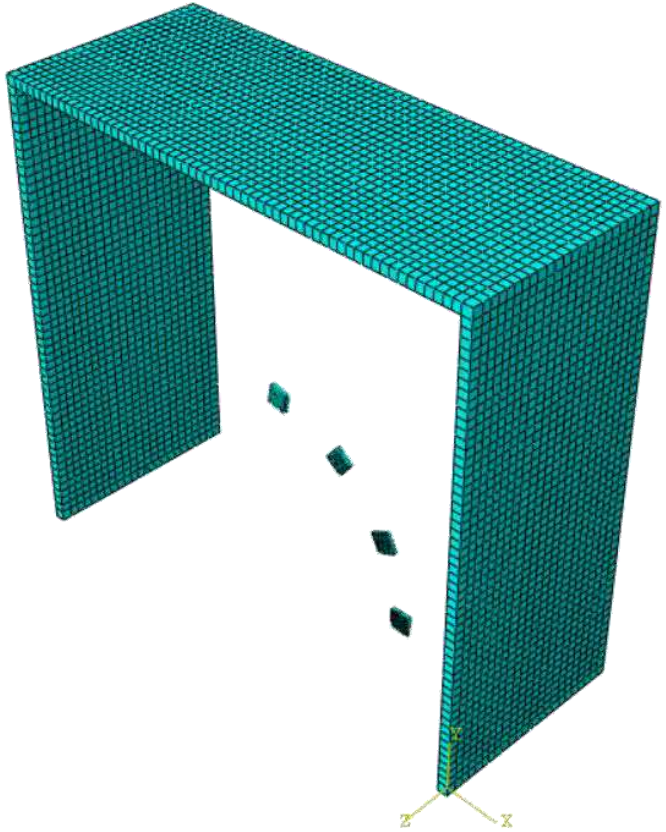


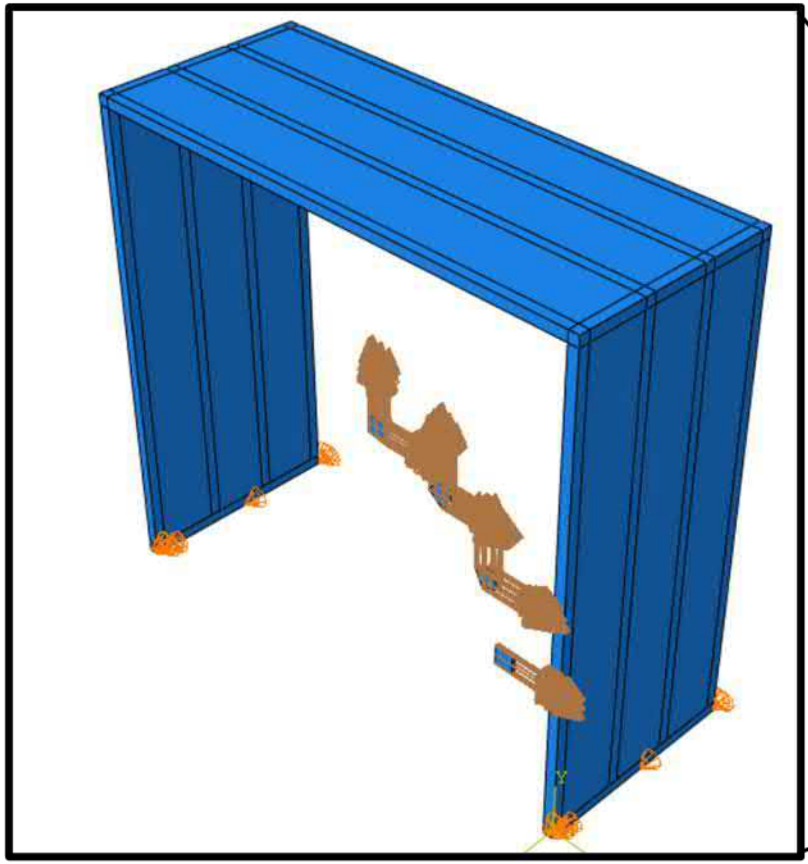


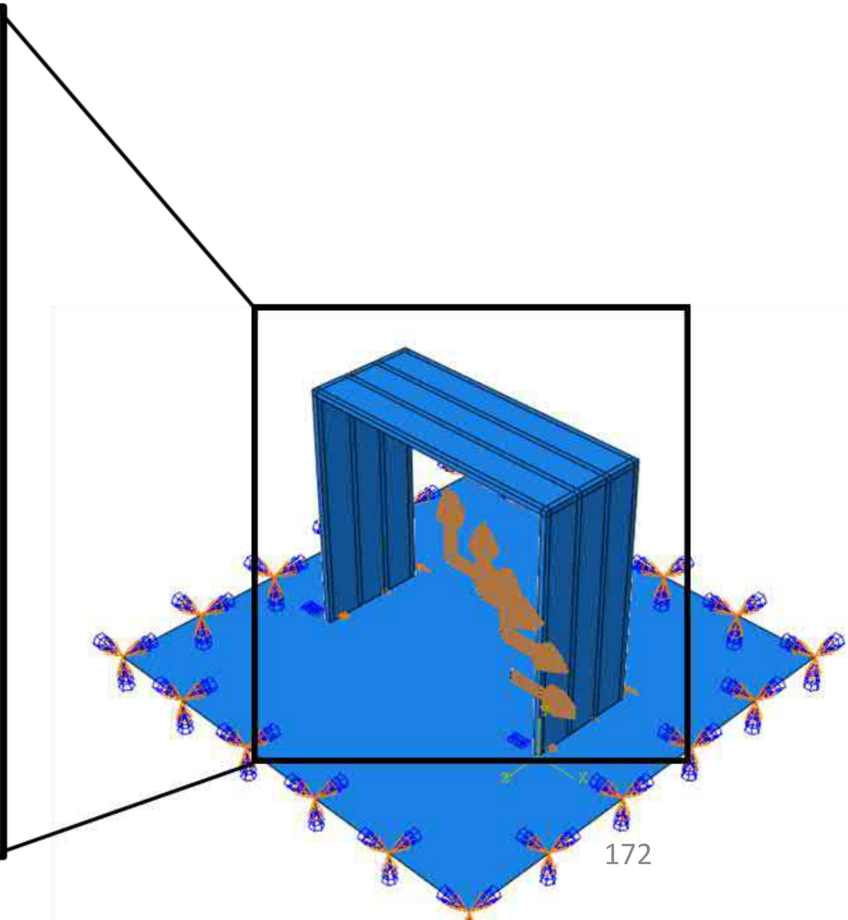
Dynamic analysis: Stability following impact

- *Projectile3.2 is a turbine fragment (1/3 of the J85 rotor) with a mass of 1.78kg.*
- *Approximated as a (0.0229x0.121x0.121m) flat plate.*
- *To investigate the safety against turnover following projectiles strike four projectiles are considered. The projectiles strike the **edges and centers** of the Top and side walls of the containment shield, hitting at a velocity of 163.7 m/s.*
- *The FEA results did not show any penetration of the armor by projectile 3.2.*



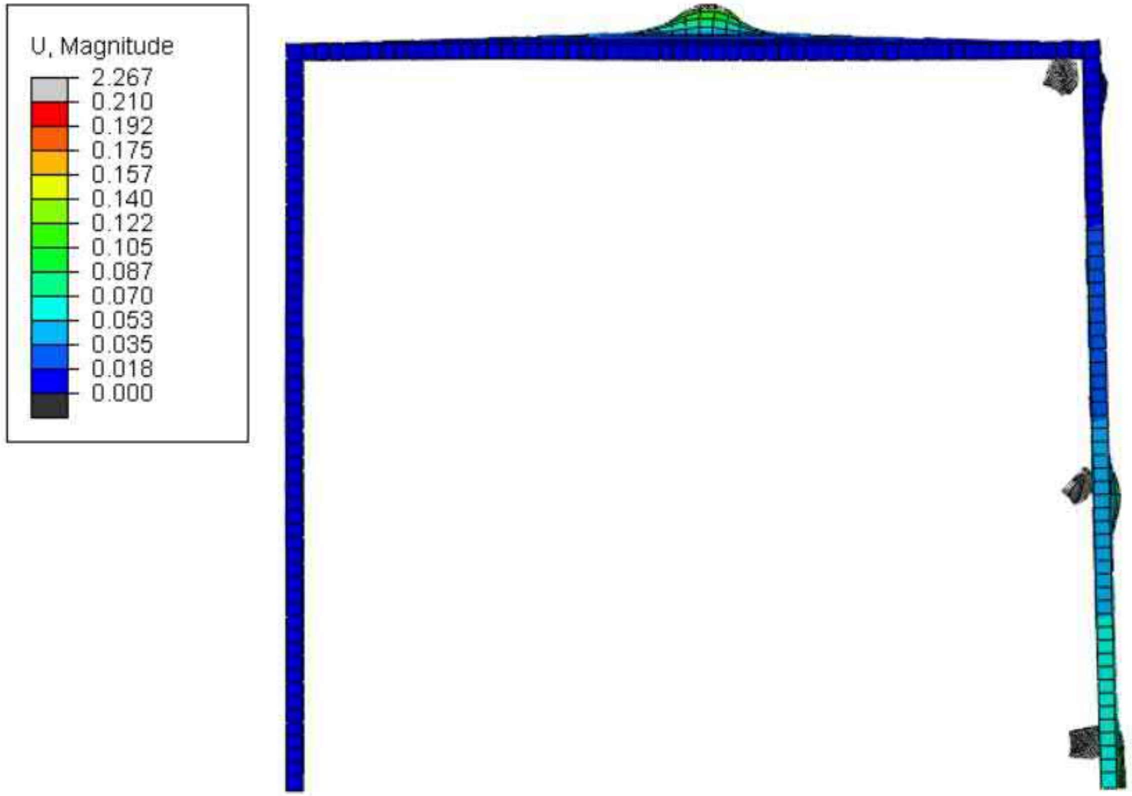




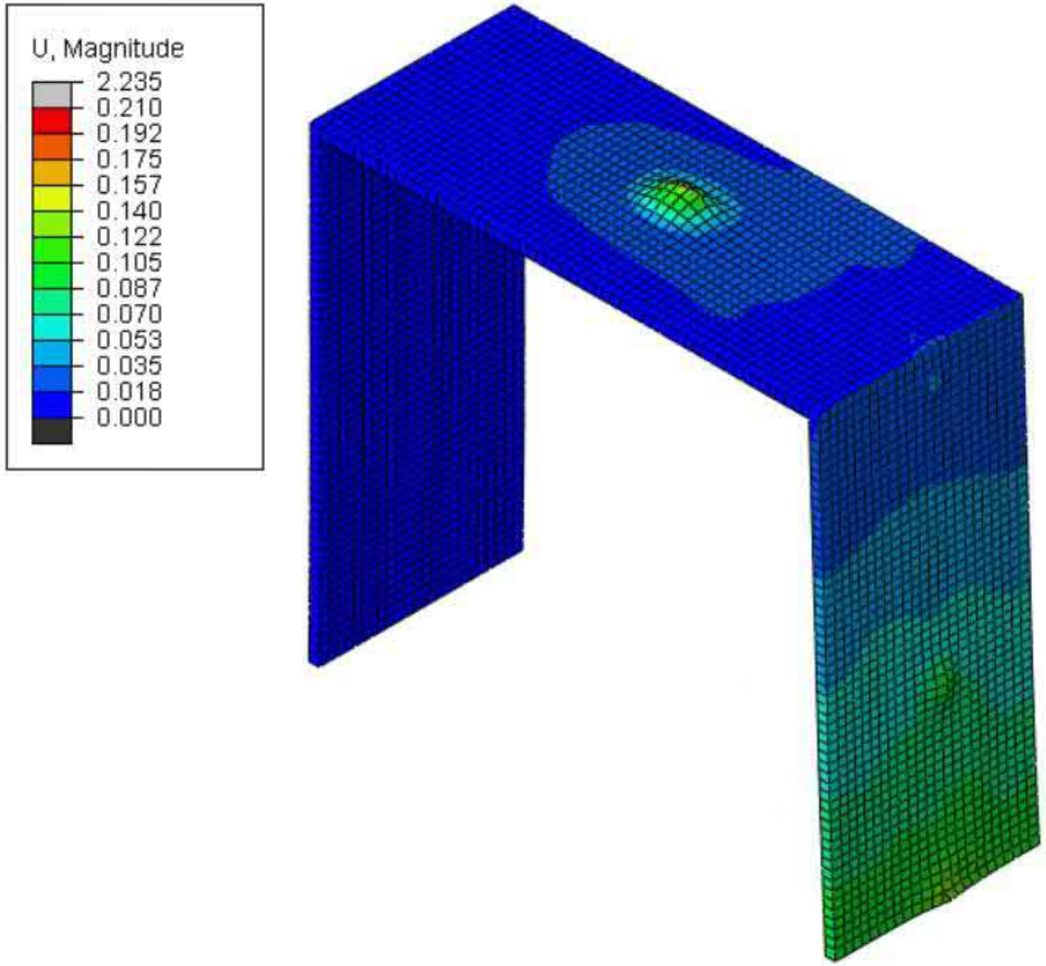


Dynamic analysis: Stability following impact

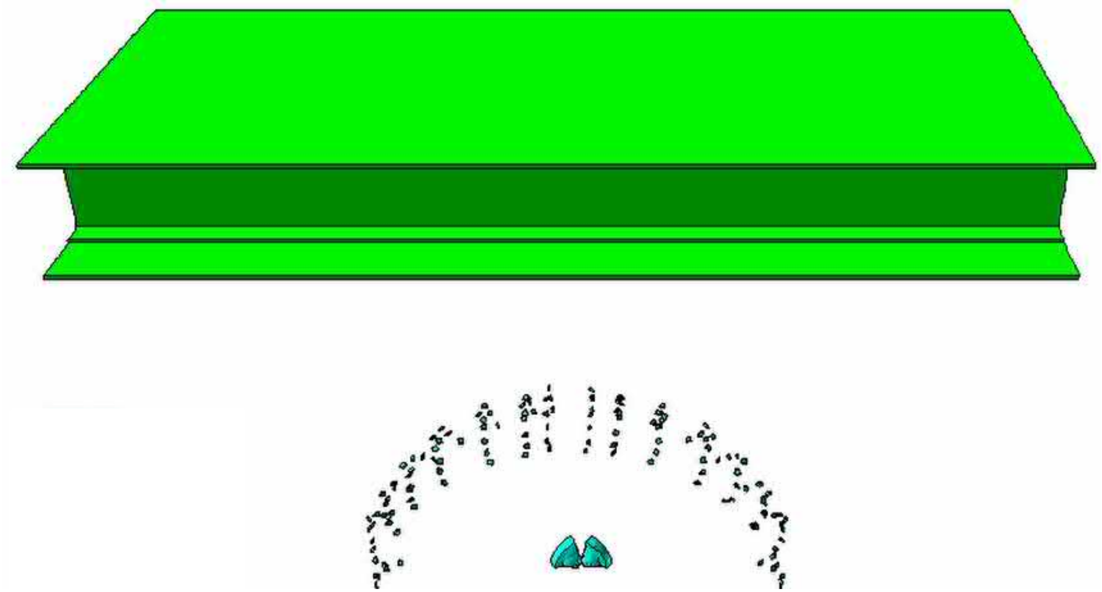
- *The FEA results are shown below. It suggests that no turnover is expected.*

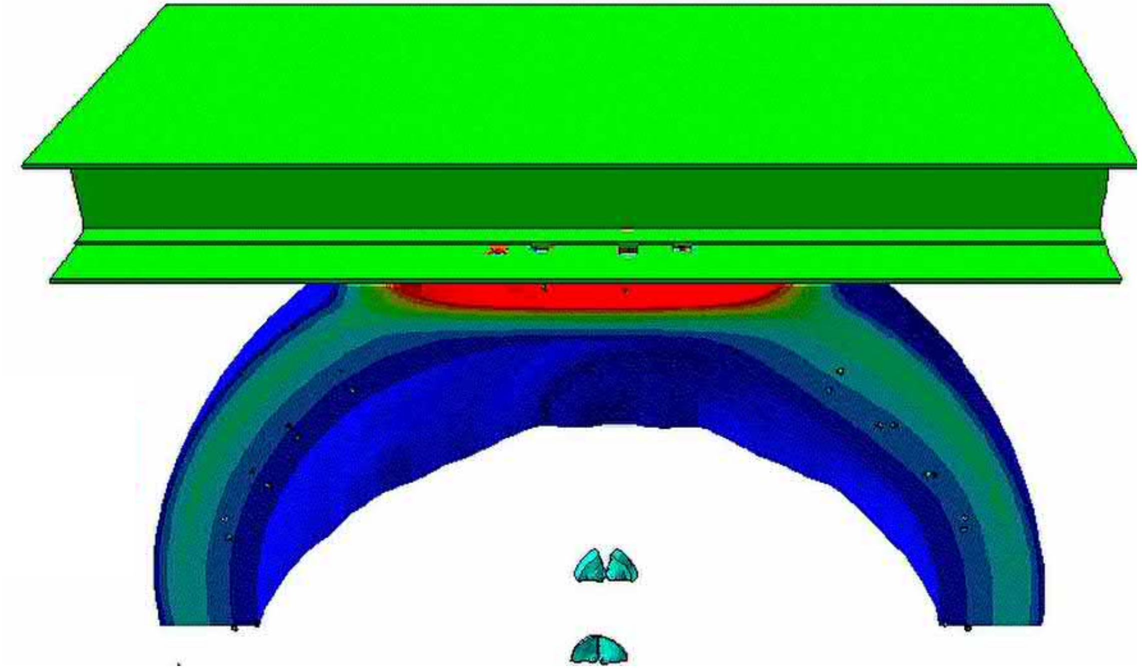


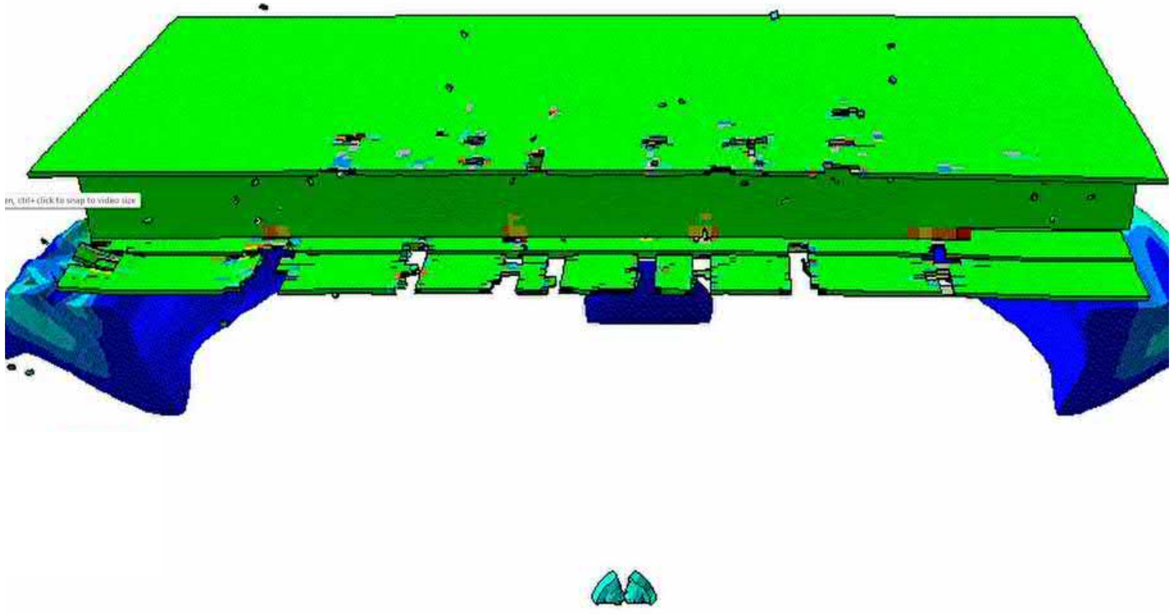
Video 1: Predicted displacement-side view



Video 2: Predicted displacement-3D view



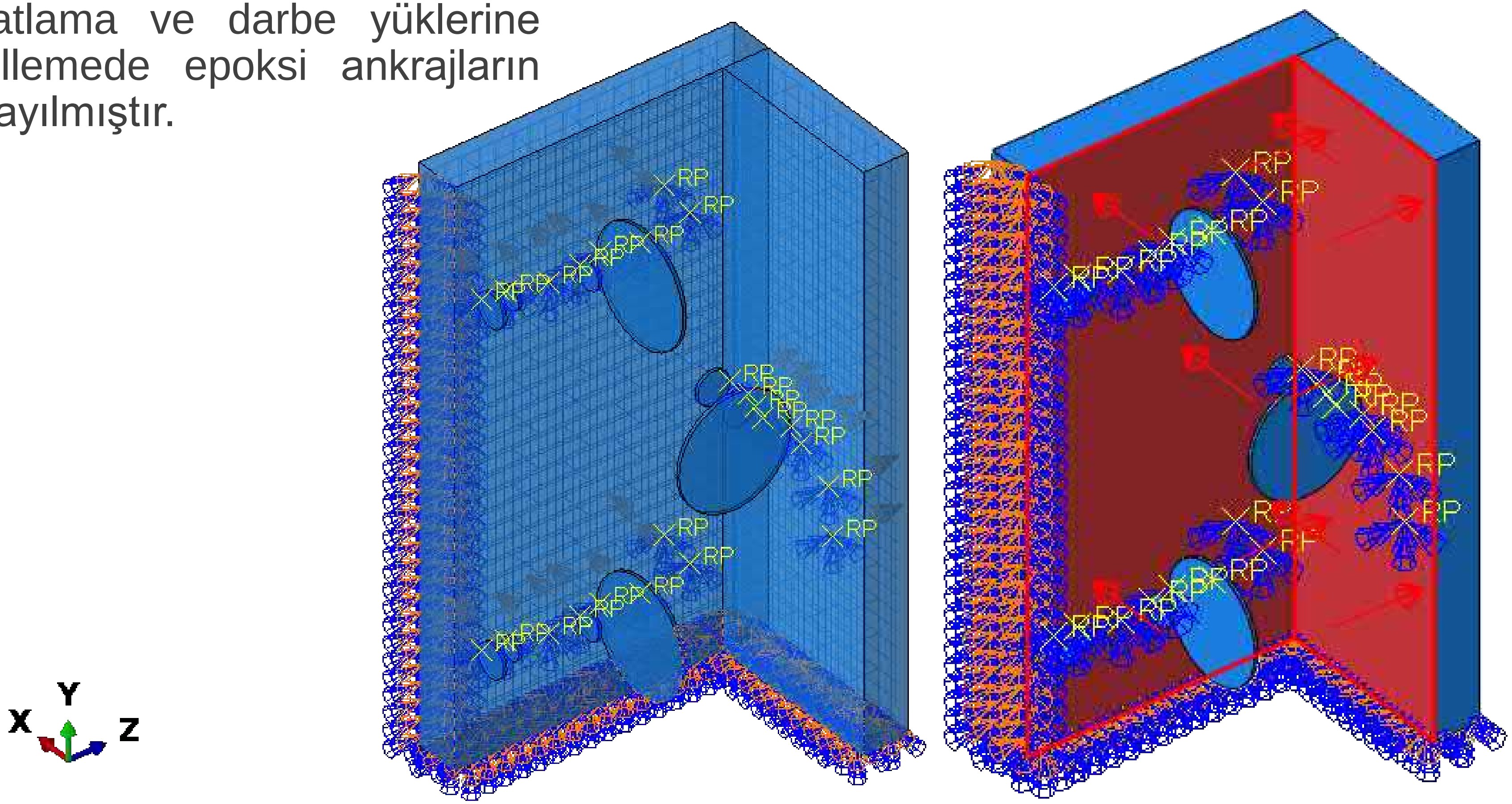




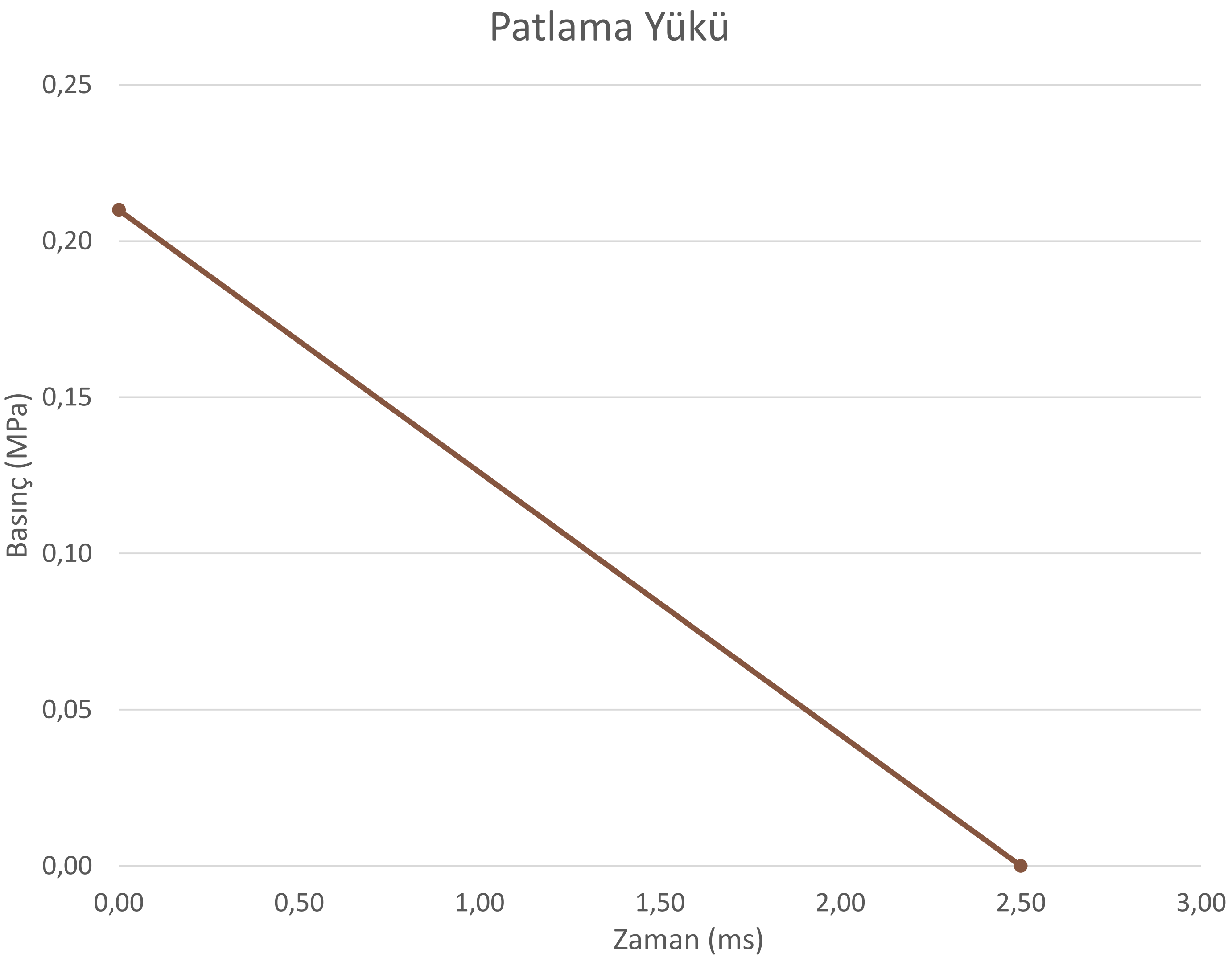
Betonarme Duvar Parçacık Etkisi

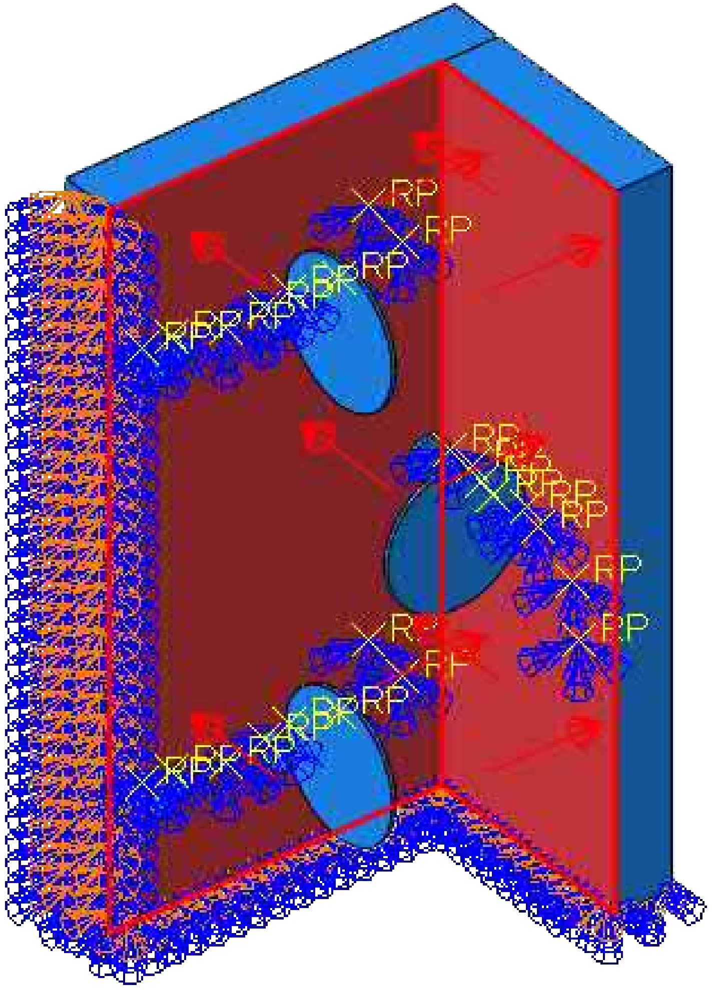
- Epoksi ankraj: Yan duvara ve zemine epoksi ankraj

- Duvarın, eş zamanlı patlama ve darbe yüklerine maruz kaldığında modellemede epoksi ankrajların yerlerine sabitlendiği varsayılmıştır.

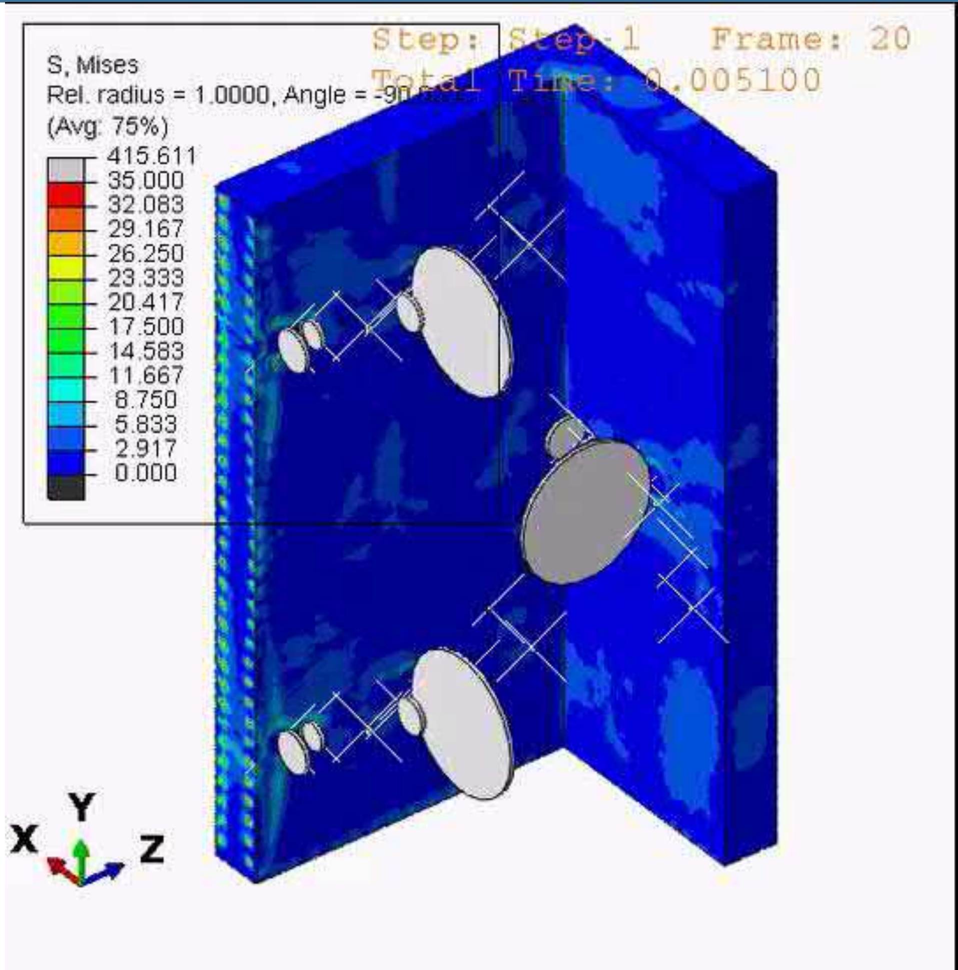


PATLAMA YÜKÜ

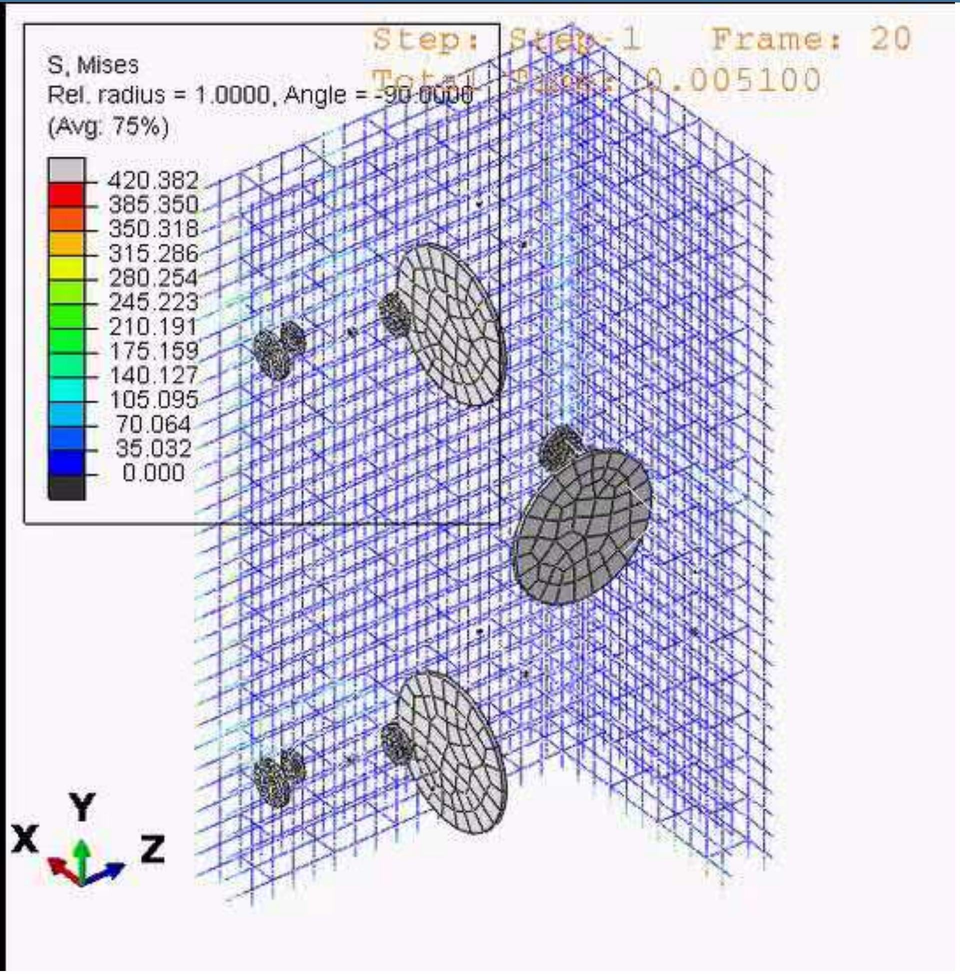




Analiz SONUÇLAR



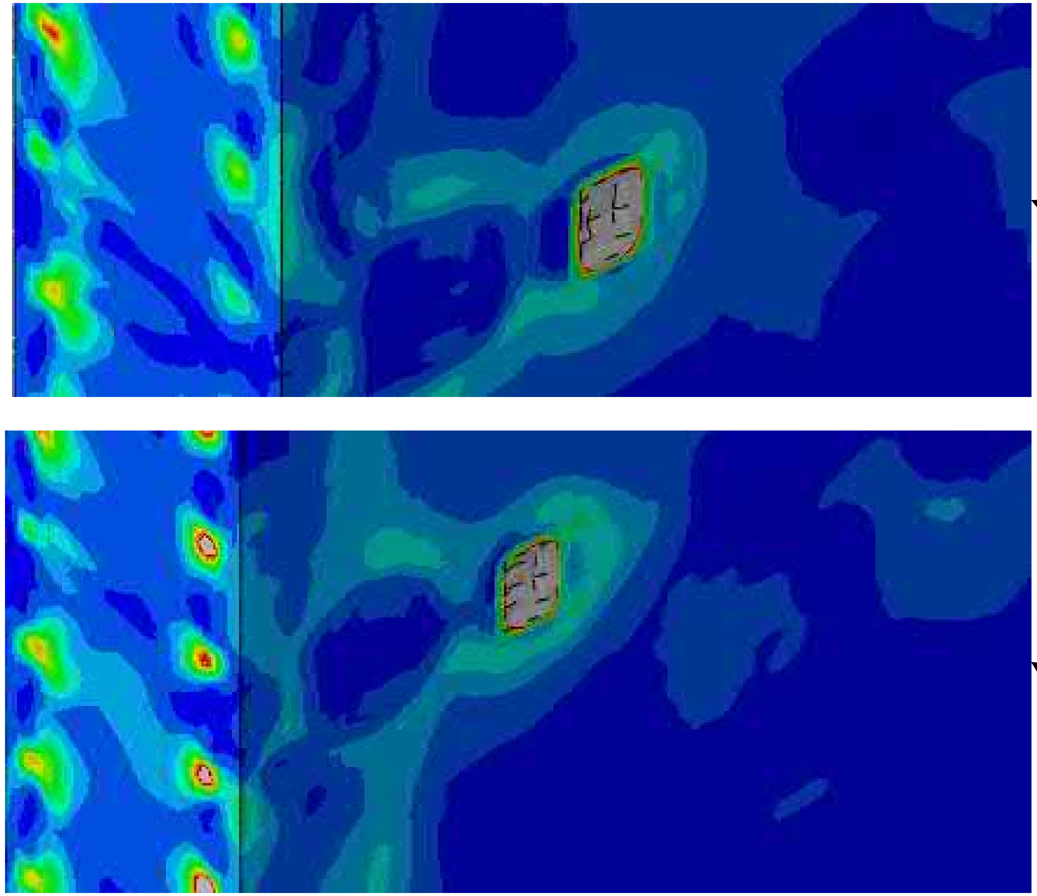
Reaktör Tarafı



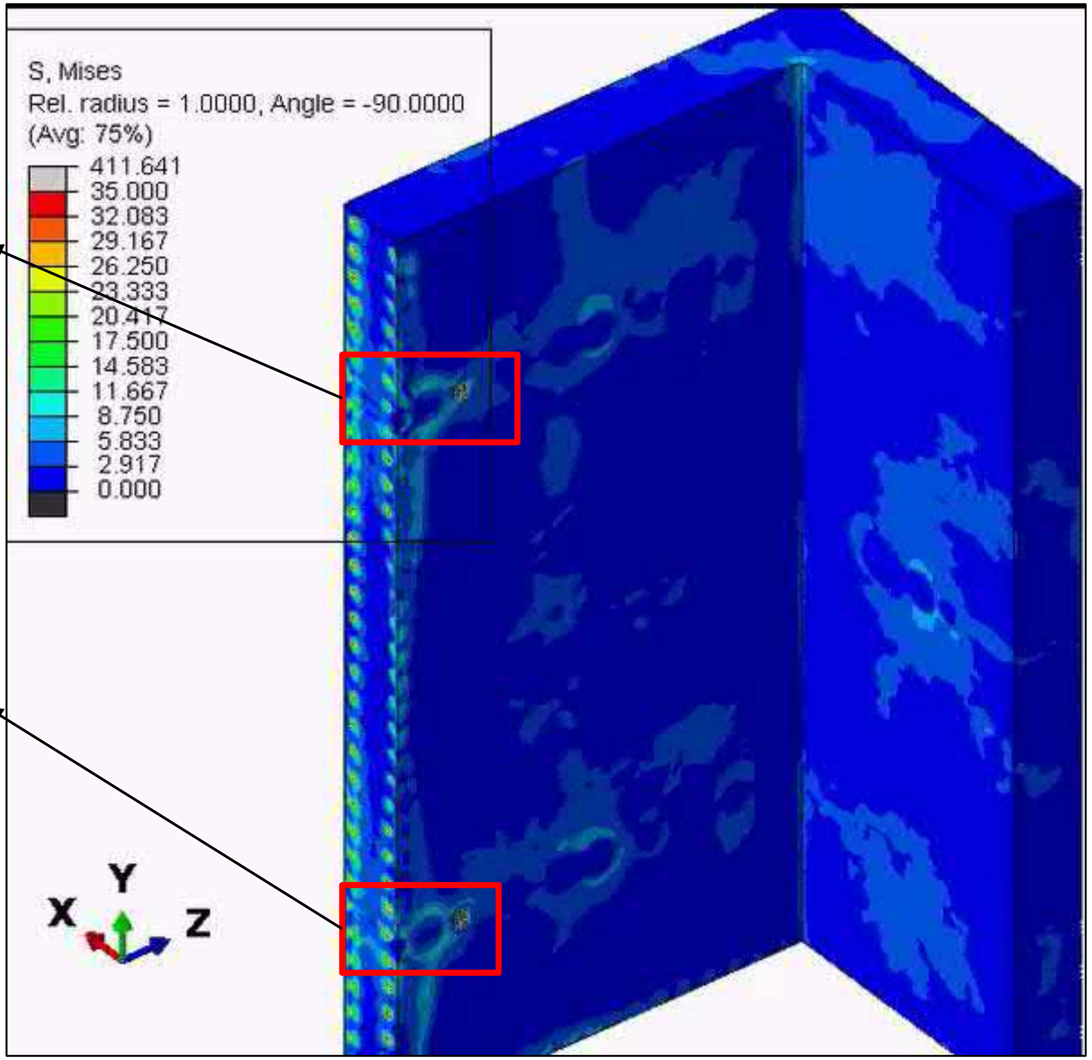
Reaktör Tarafı

Stress Von Mises (MPa)

Analiz SONUÇLAR



Betonda oluşan yerel hasar ve çatlaklar



BLEVE Patlaması

On July 11, 1978, a tank carrying propylene left the road and crashed into a camp site. A leak developed and the ensuing cloud ignited. Three minutes later, the tank failed completely. A fireball was generated and fragments were projected. In total 211 people were killed. The number of injured is unknown.

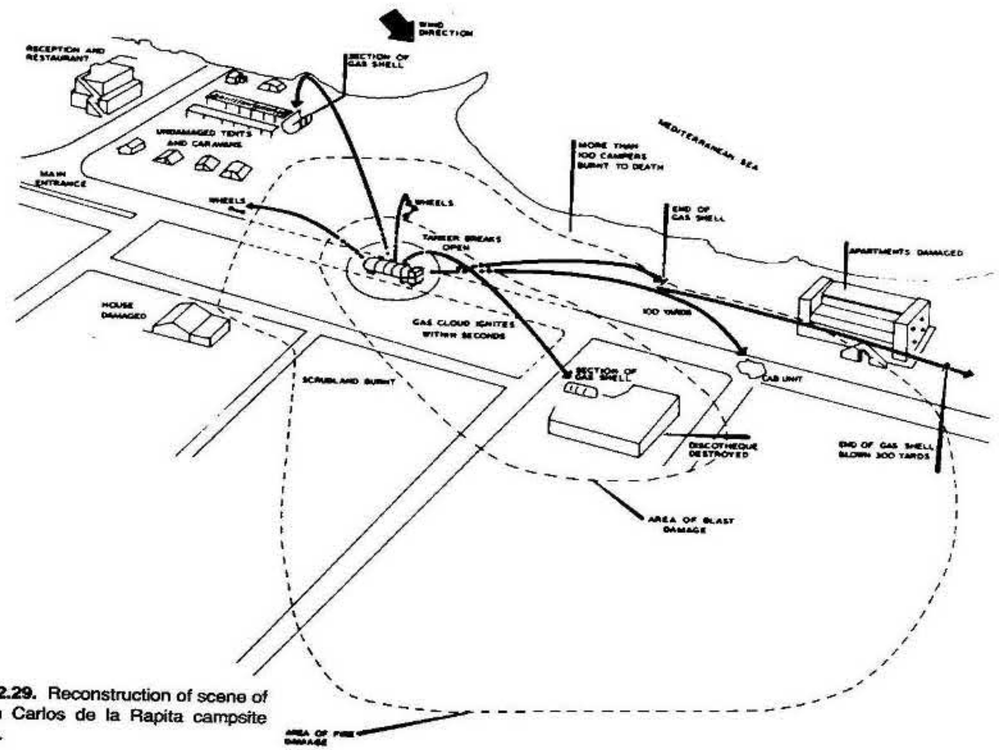
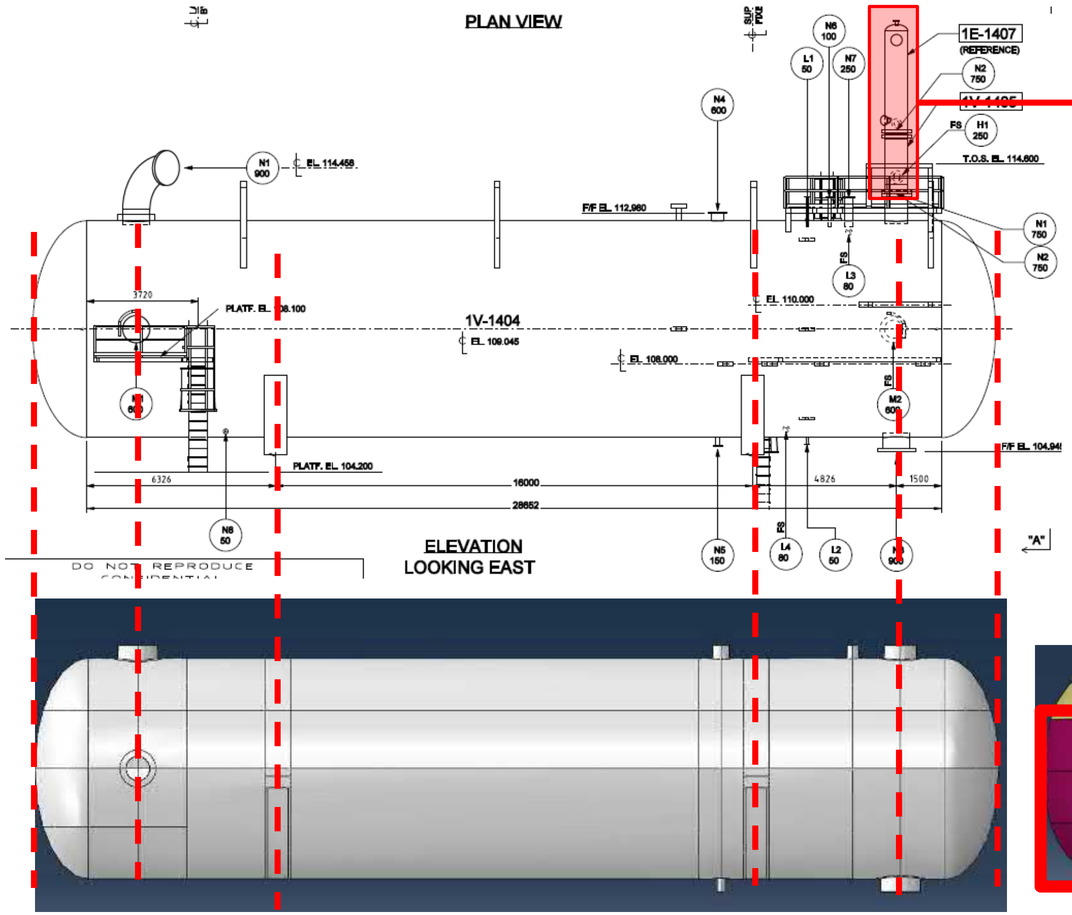


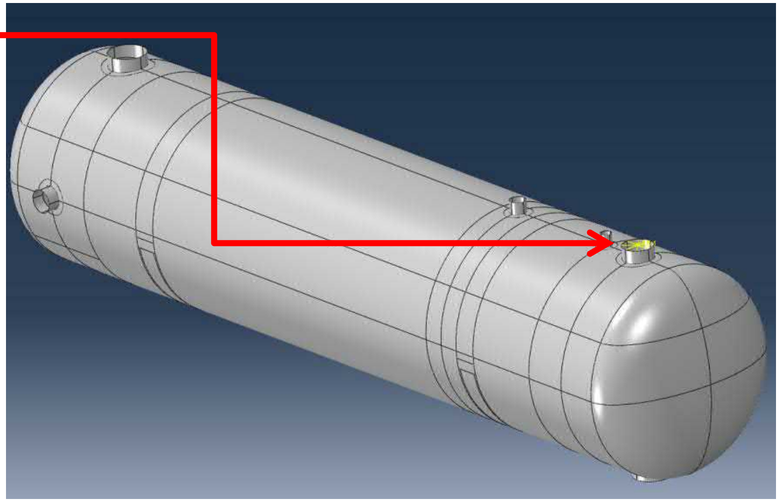
Figure 2.29. Reconstruction of scene of the San Carlos de la Rapita campsite disaster.

Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions, FLASH Fires, and BLEVEs **Cen. for Chemical Process Safety for AICHE New York, NY. 1994**

BLEVE

Length	Diameter	Thickness	Content
32.23 m	7.16 m	62 mm	Propane

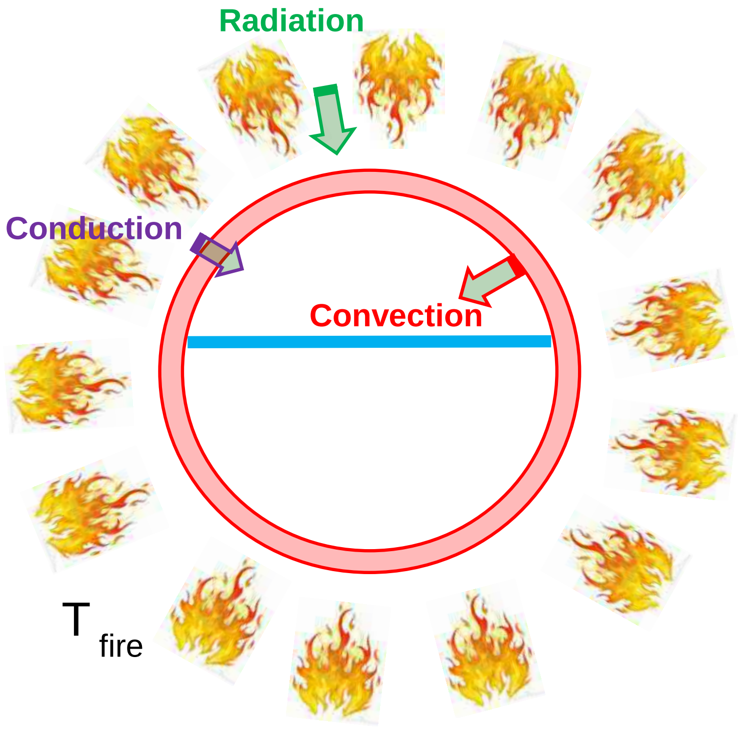




Liquid fill level (HLL)

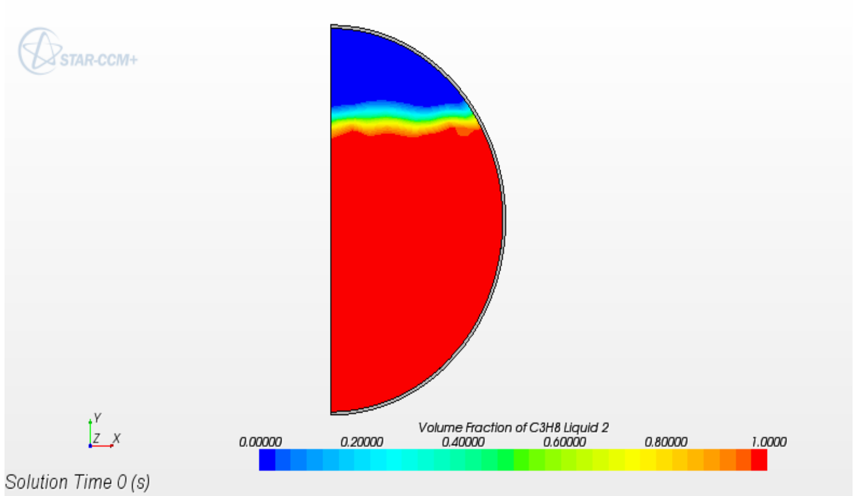
BLEVE

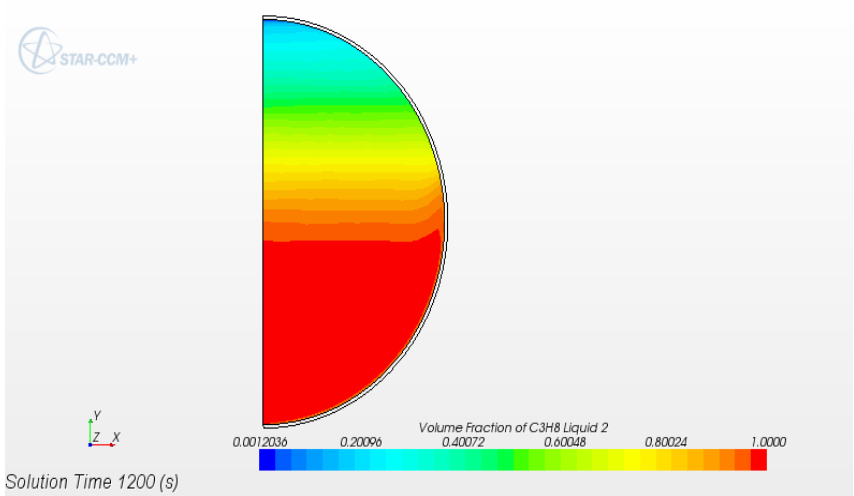
- Modes of heat transfer considered in the CFD models:
  - Radiation of heat from fire to the vessel wall
  - Conduction of heat through the vessel wall
  - Convection of heat from the vessel wall to the liquid and vapor content within the vessel

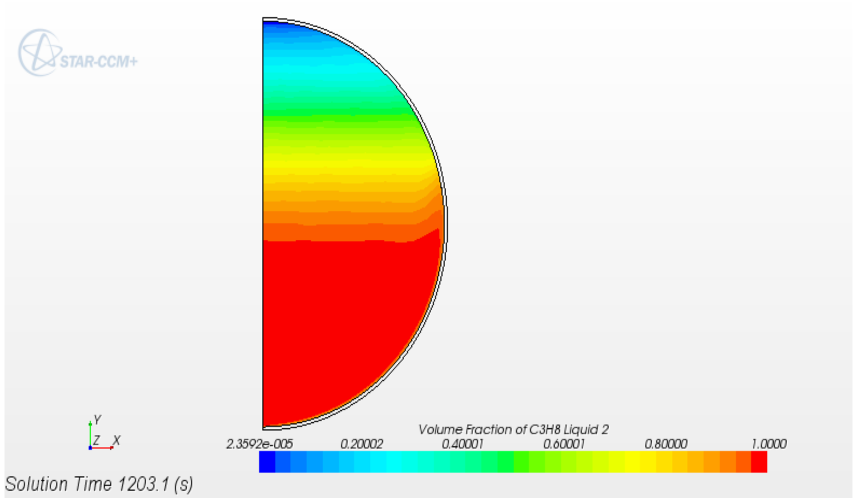


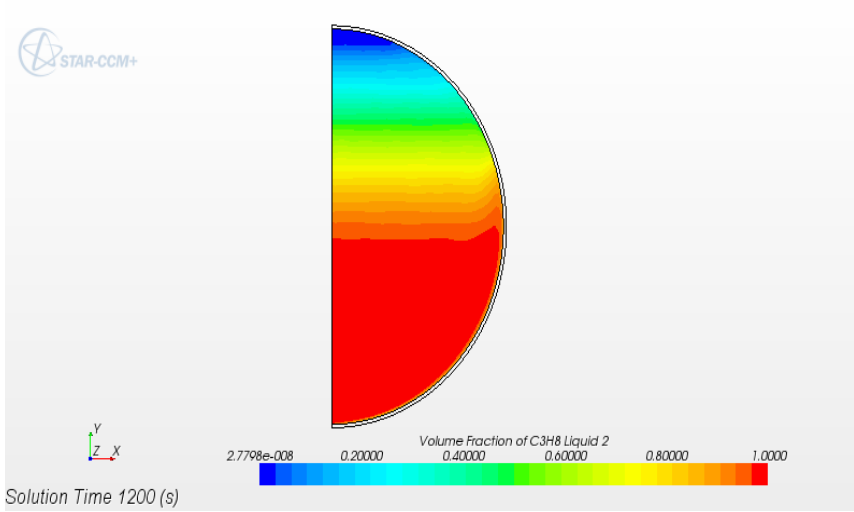
Heat transfer modes in the CFD models

Tank - CFD analizi

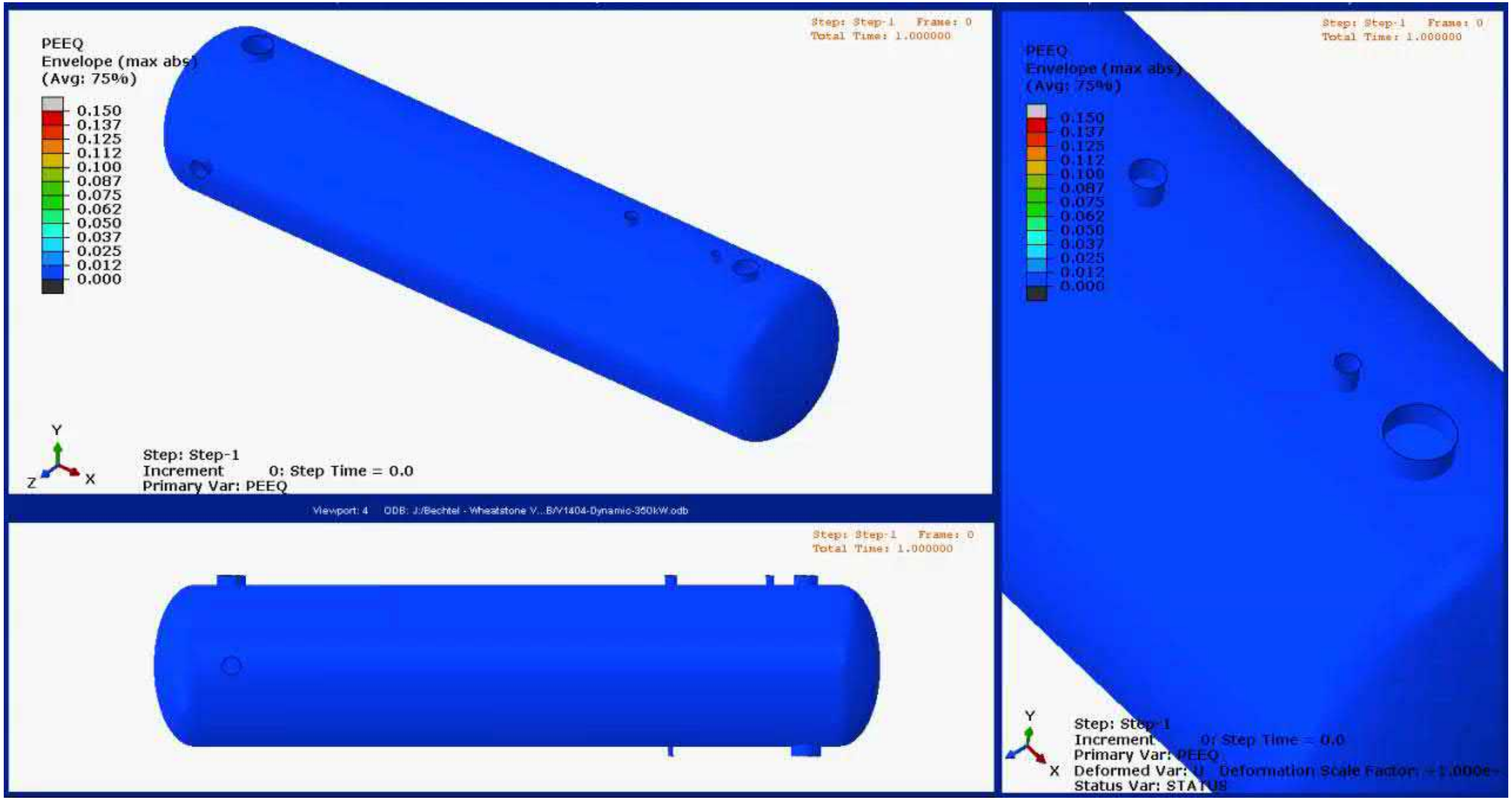






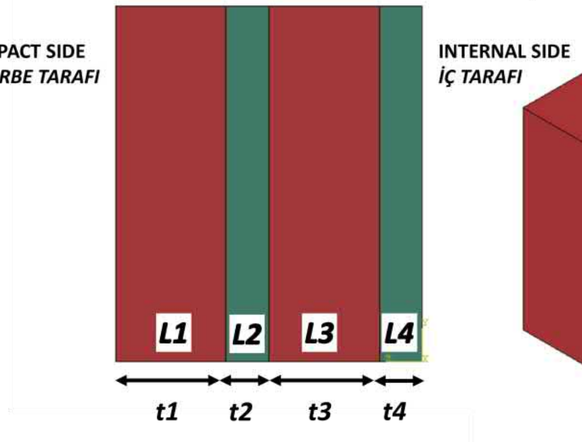


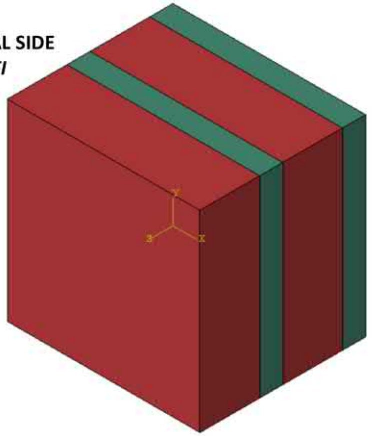
Tank Göçmesi - BLEVE

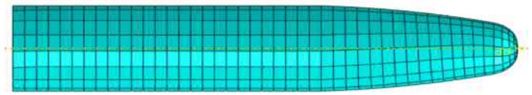


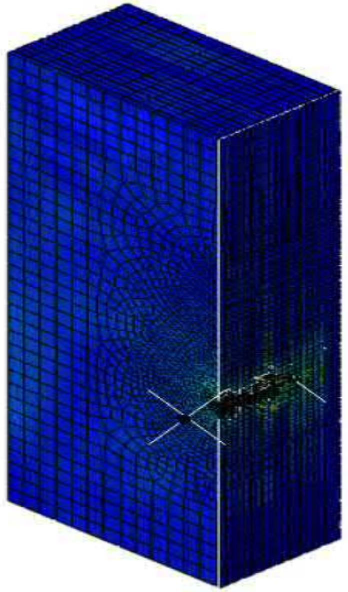
Kurşun Etkisi

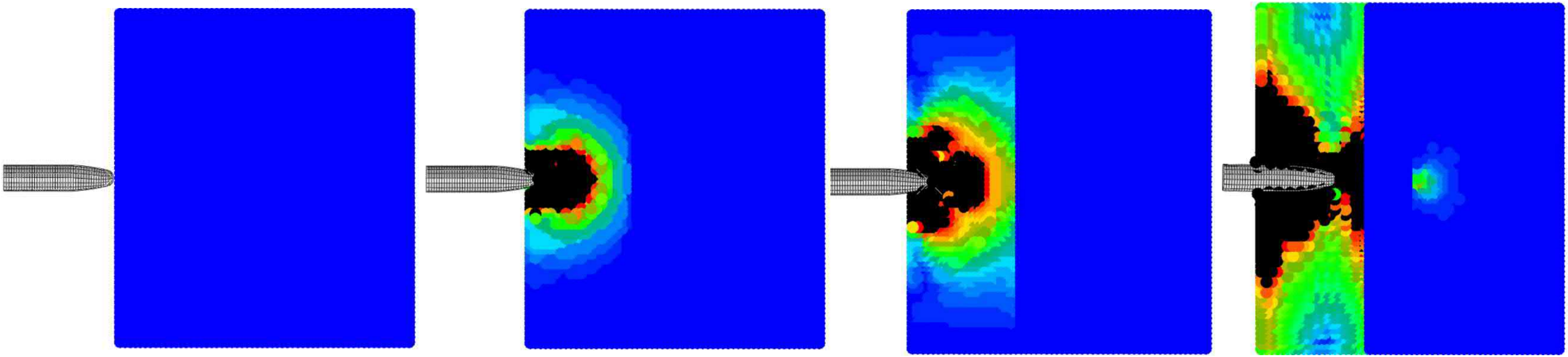
Lamine Cam Kurşun Penetrasyonu



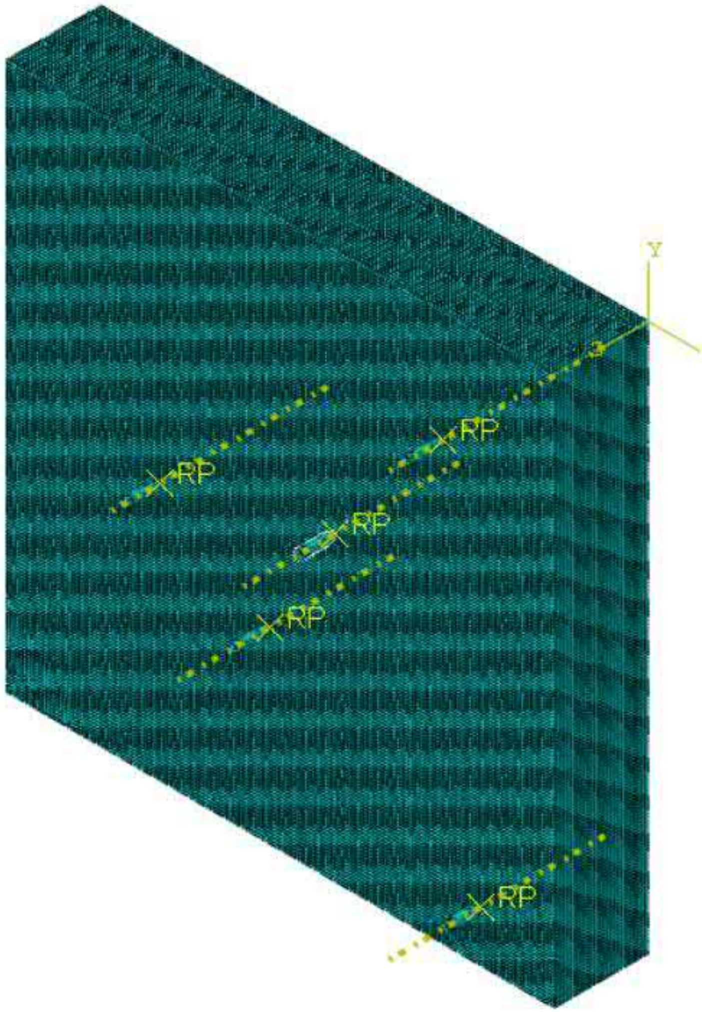


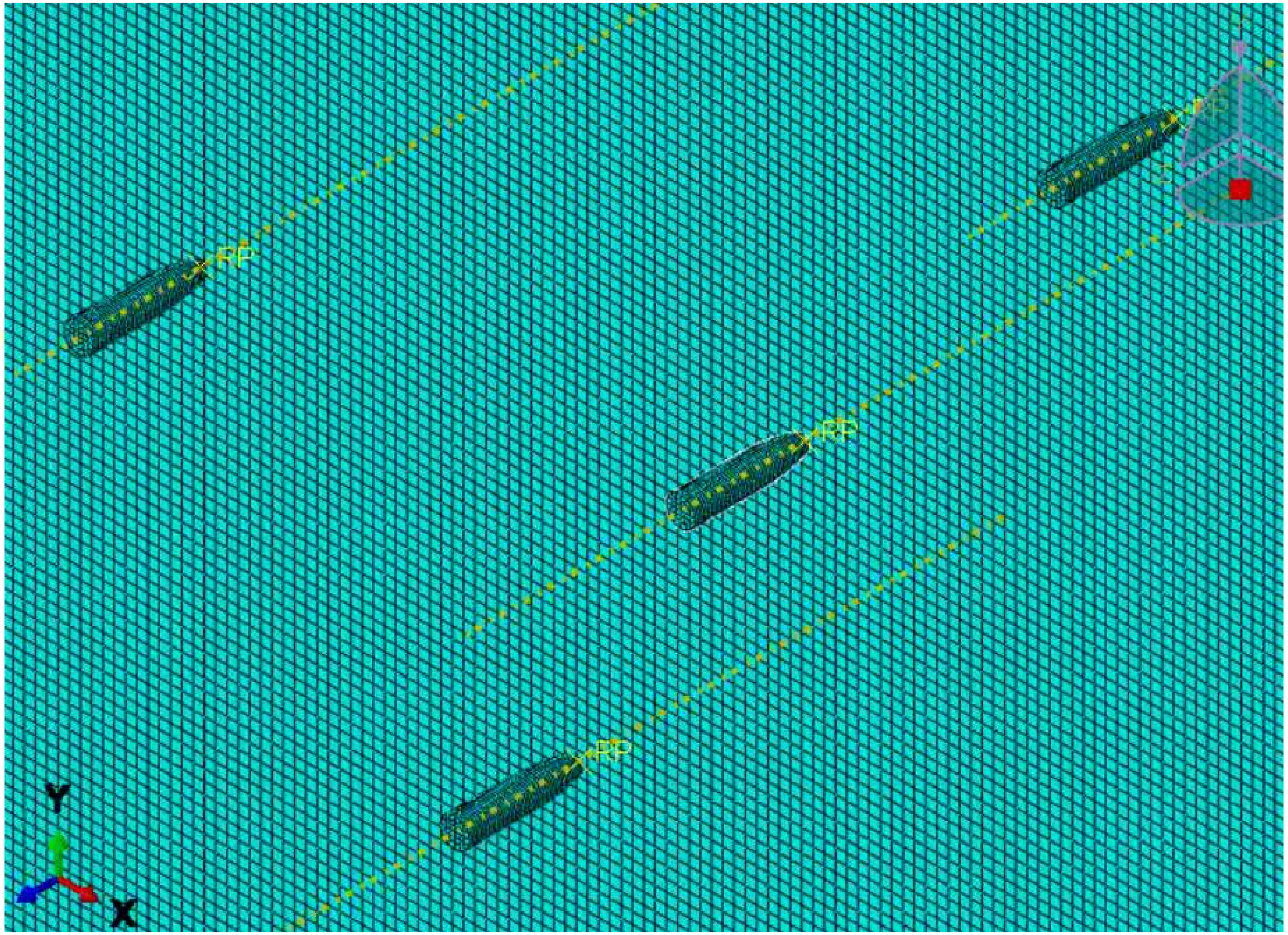




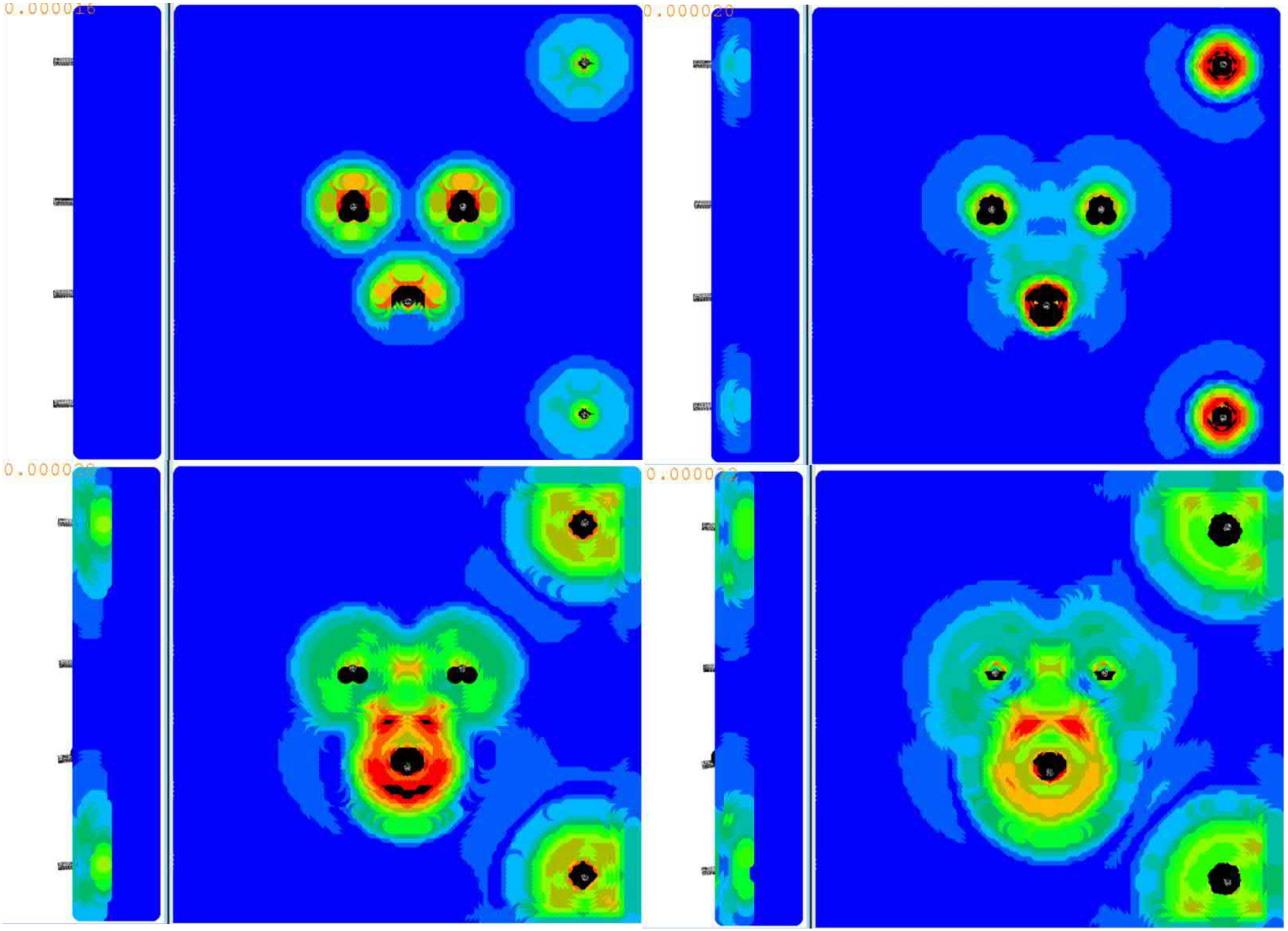


Lamine Cam Kurşun Penetrasyonu

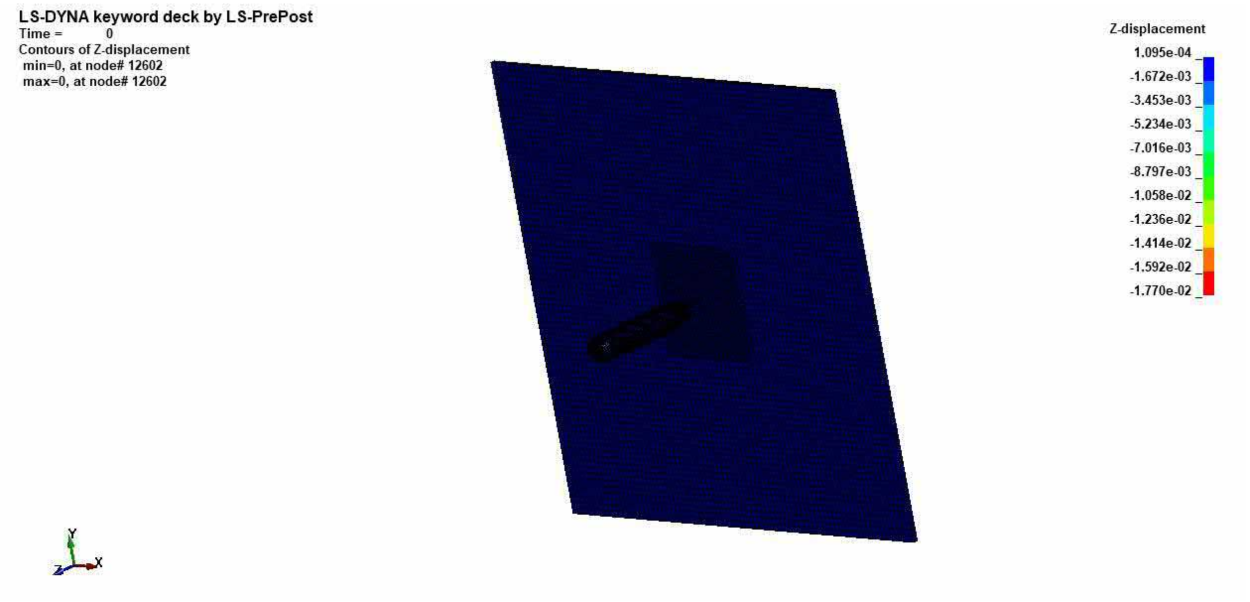


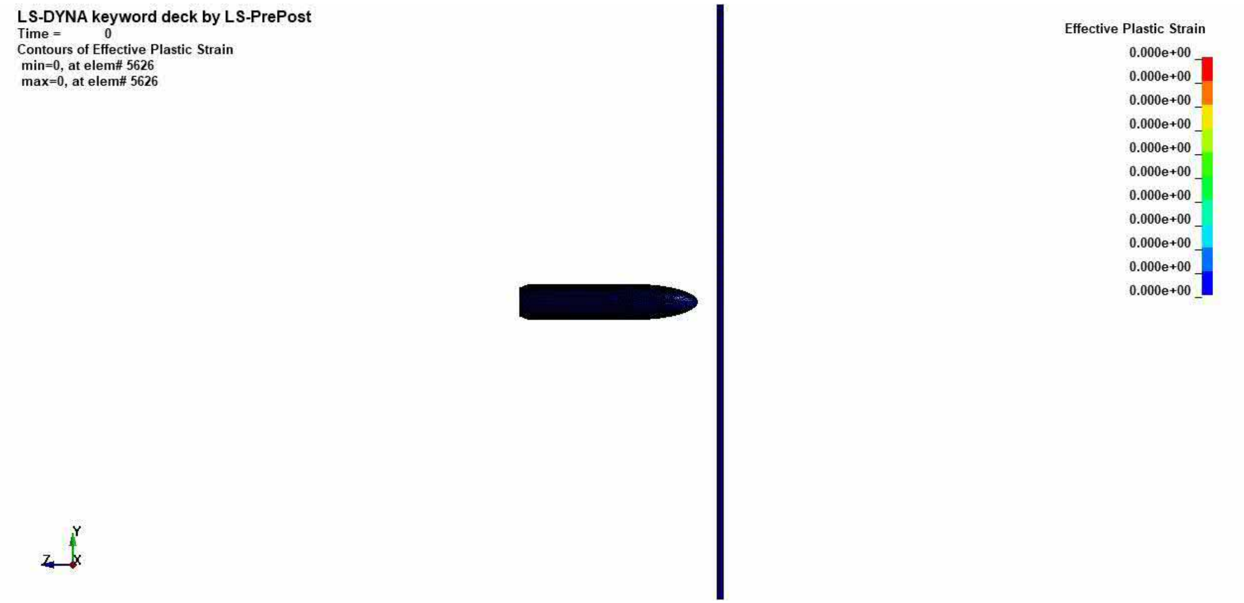


Lamine Cam Kurşun Penetrasyonu



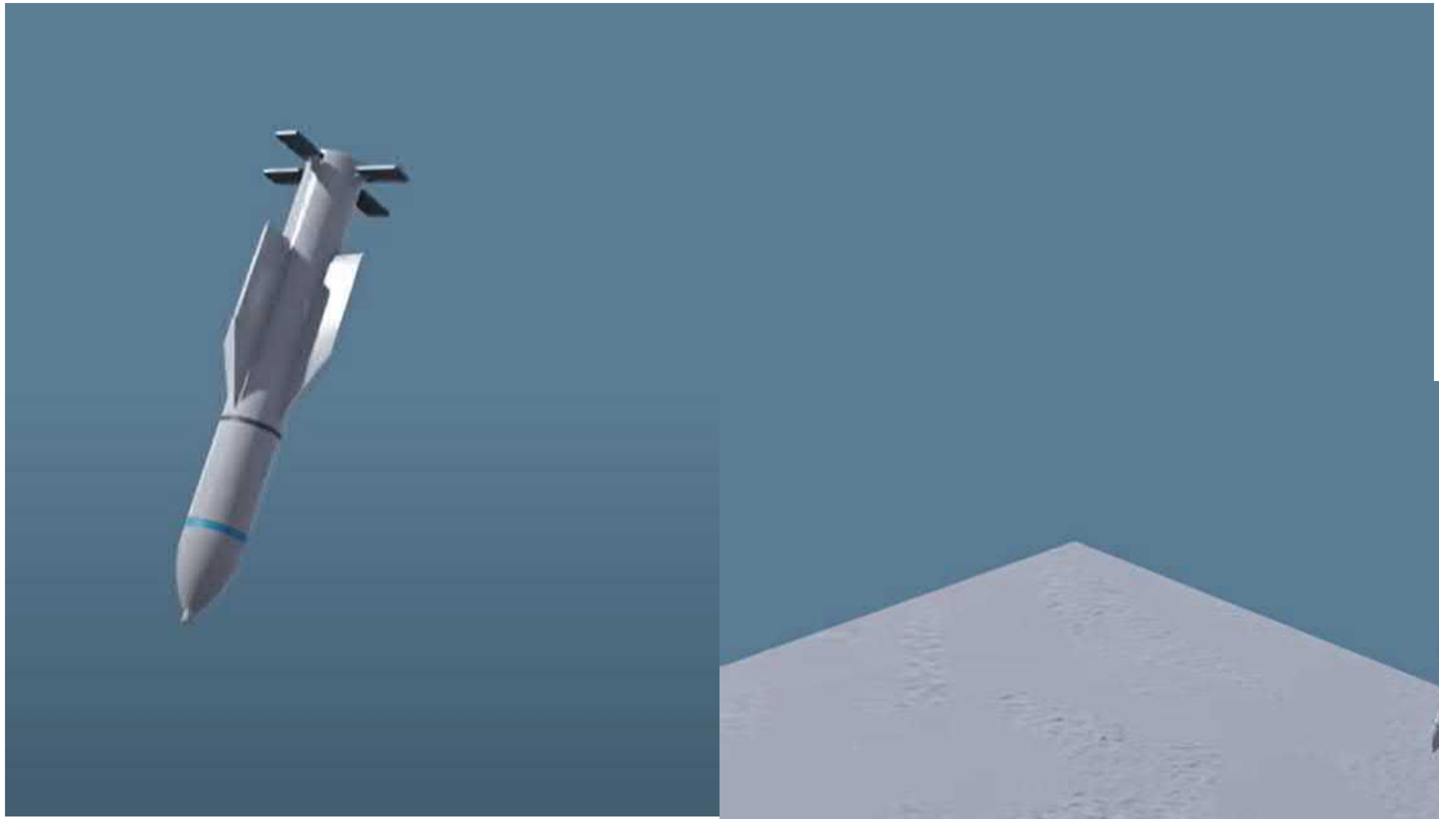
Çelik Kurşun Penetrasyonu



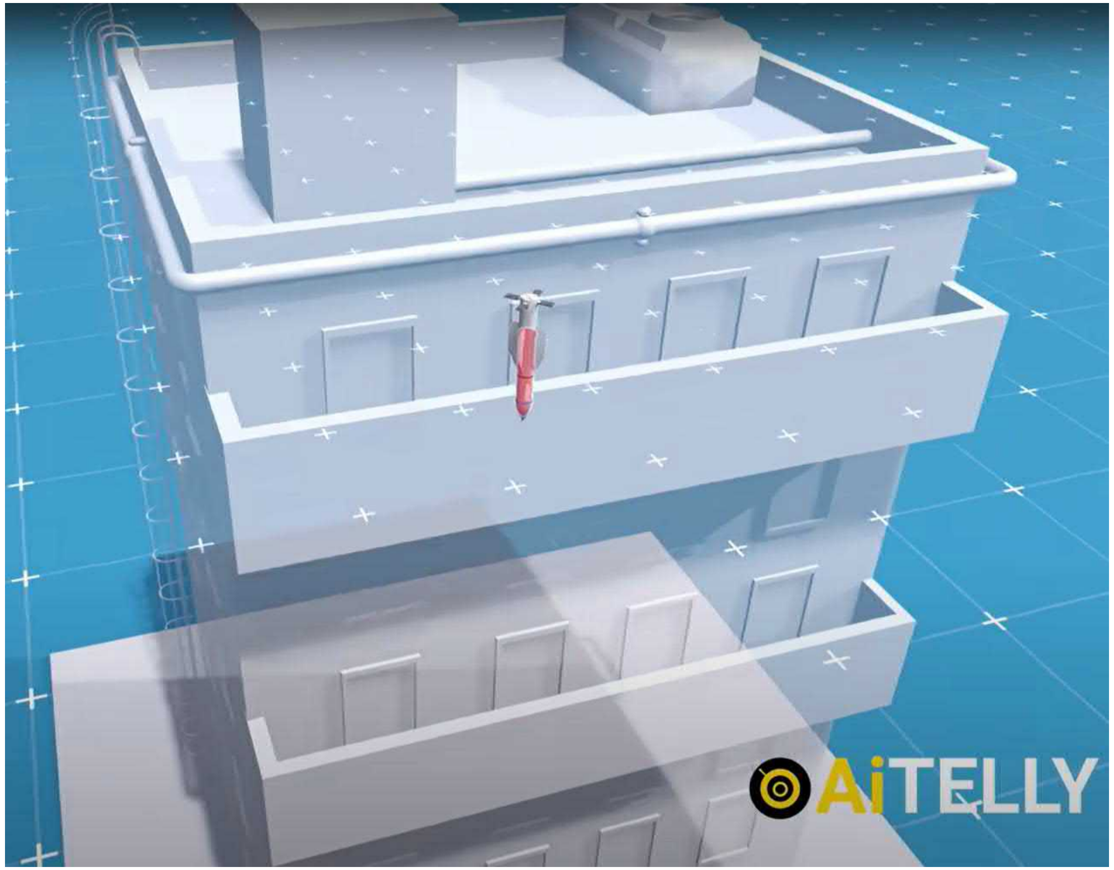


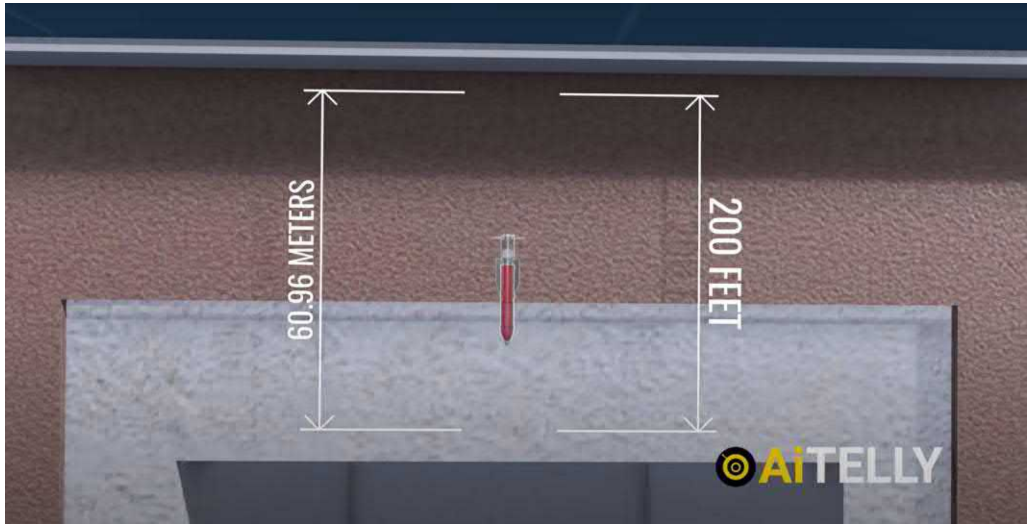
Yeraltı Sığınak Analizi

Askeri Sığınaklar

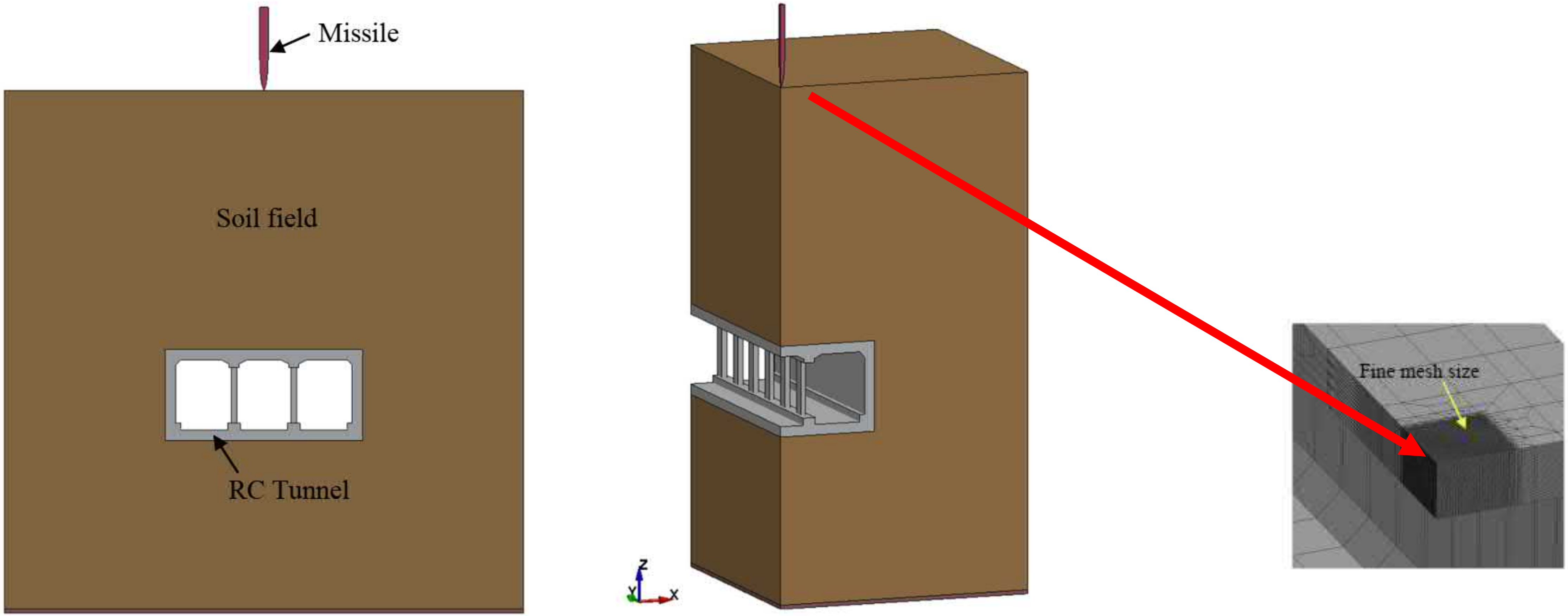


Askeri Sığınaklar

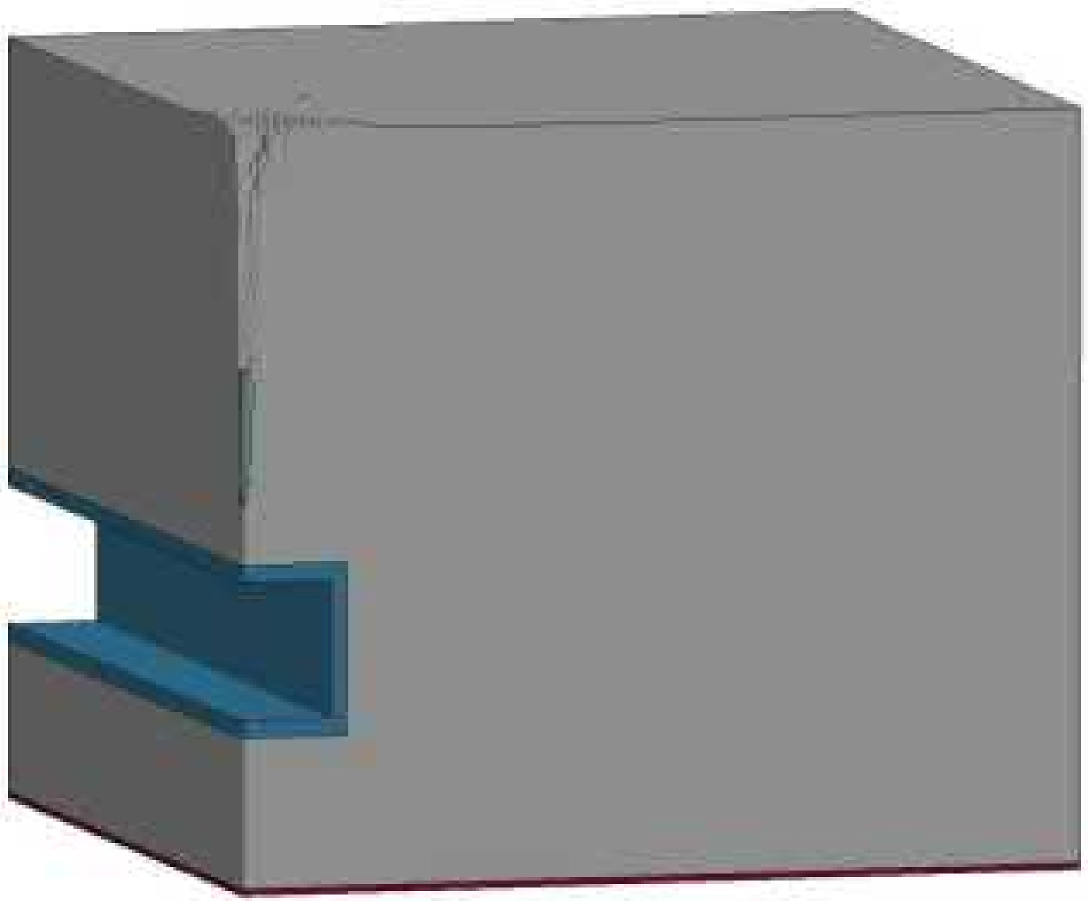


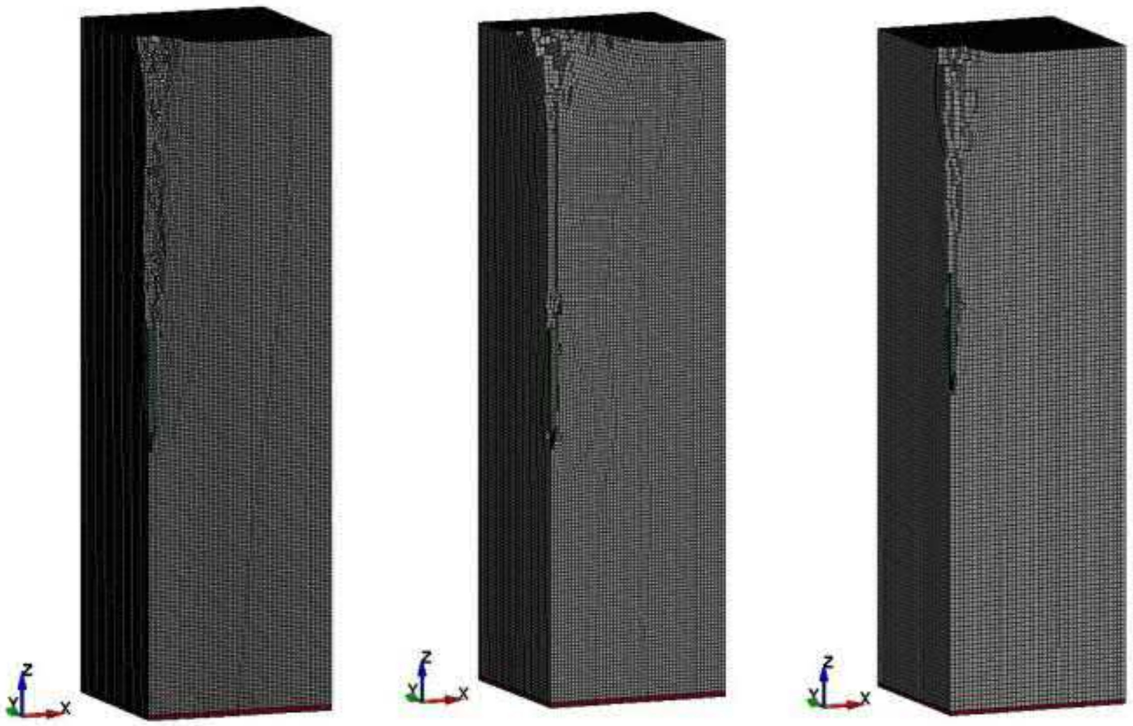


Askeri Sığınaklar

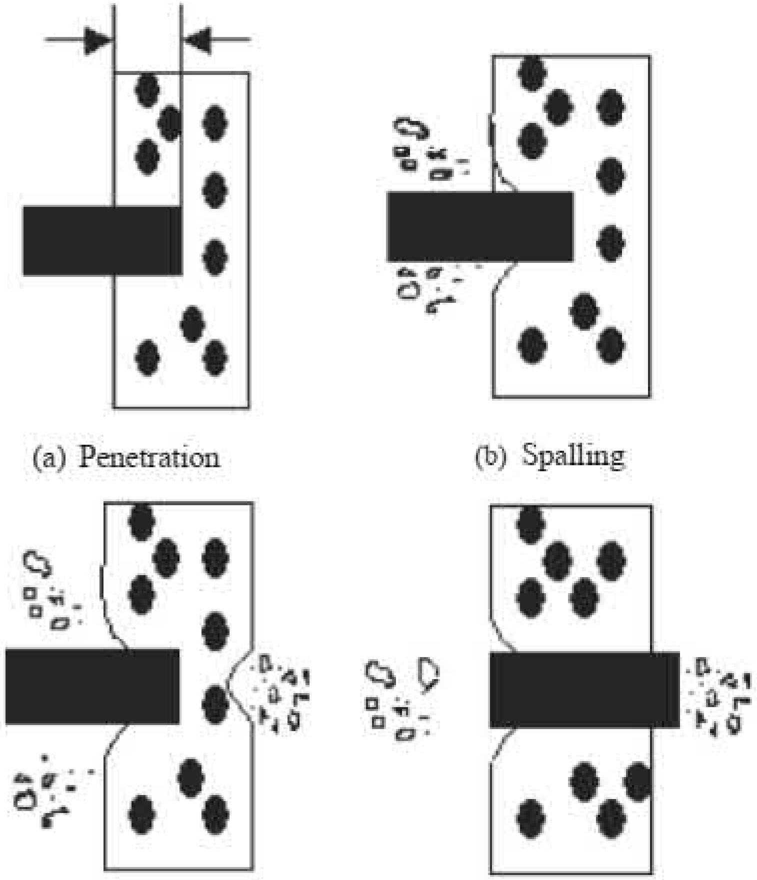


Askeri Sığınaklar





Askeri Sığınaklar

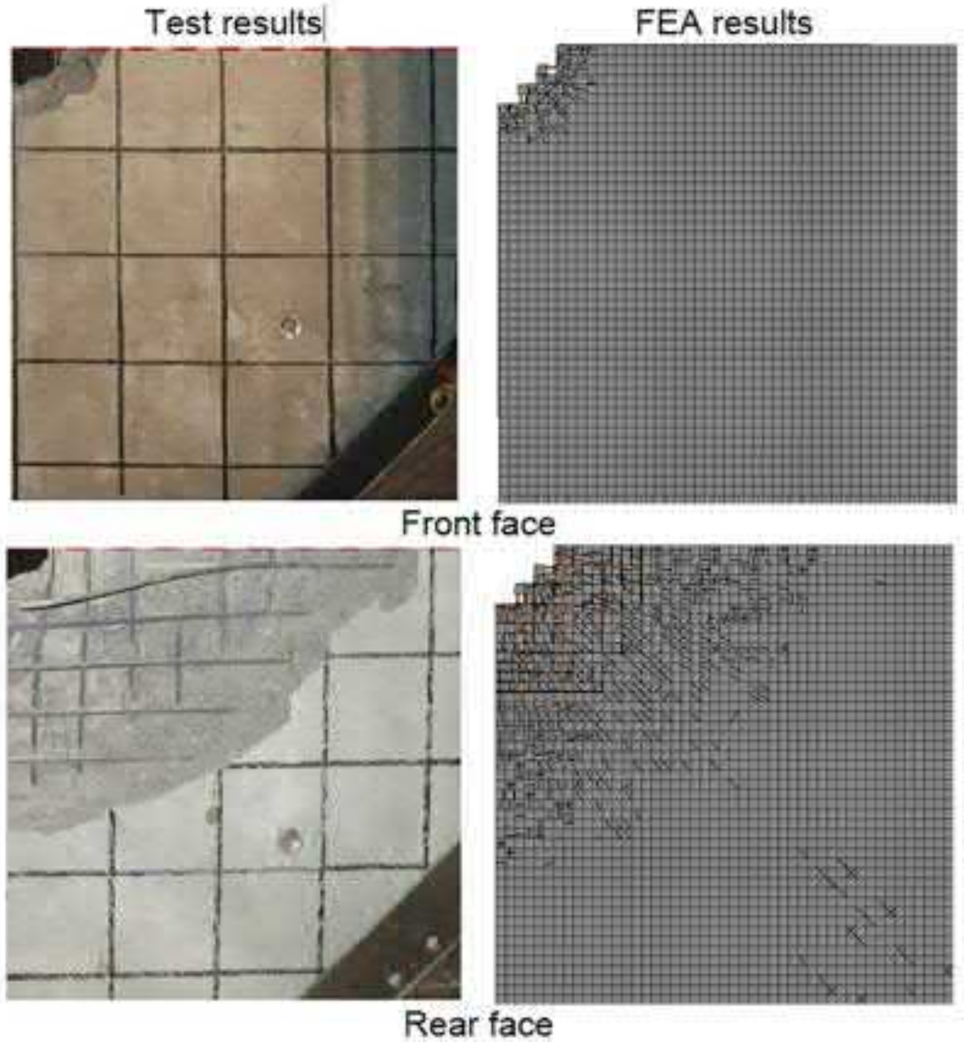


(a) Penetration

(b) Spalling

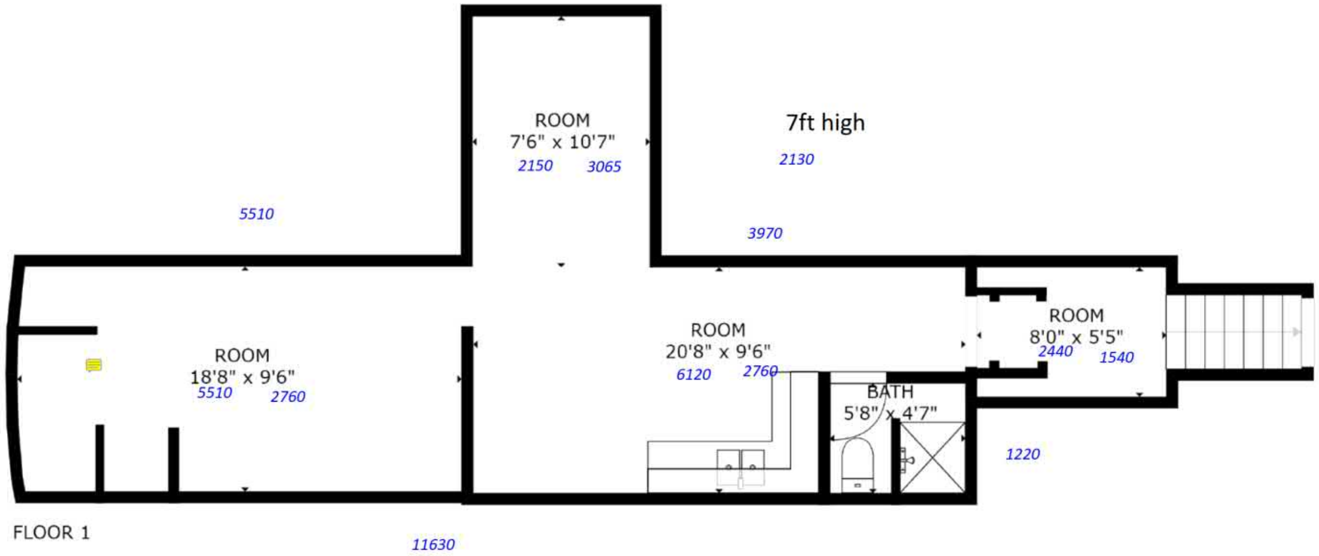
(c) Scabbing

(d) Perforation

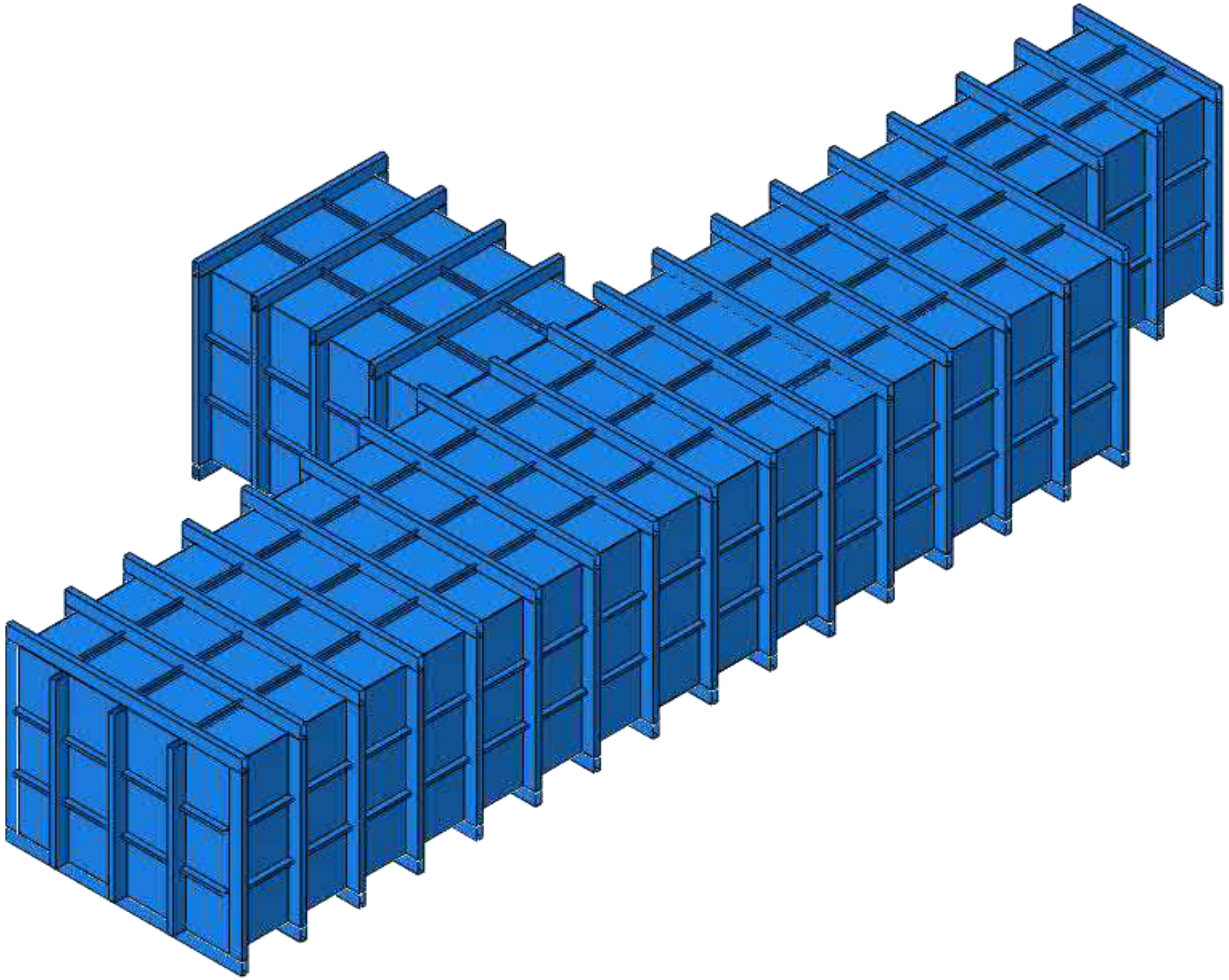


Sivil Sığınaklar

- *A finite element analysis is conducted to model a bunker with geometrical details provided.*
- *The purpose of this analysis is to estimate the internal blast load that causes the observed failure.*
- *The units used are* ***Force: N| Length: mm| Weight: kg| Time: sec| Pressure: MPa****.*

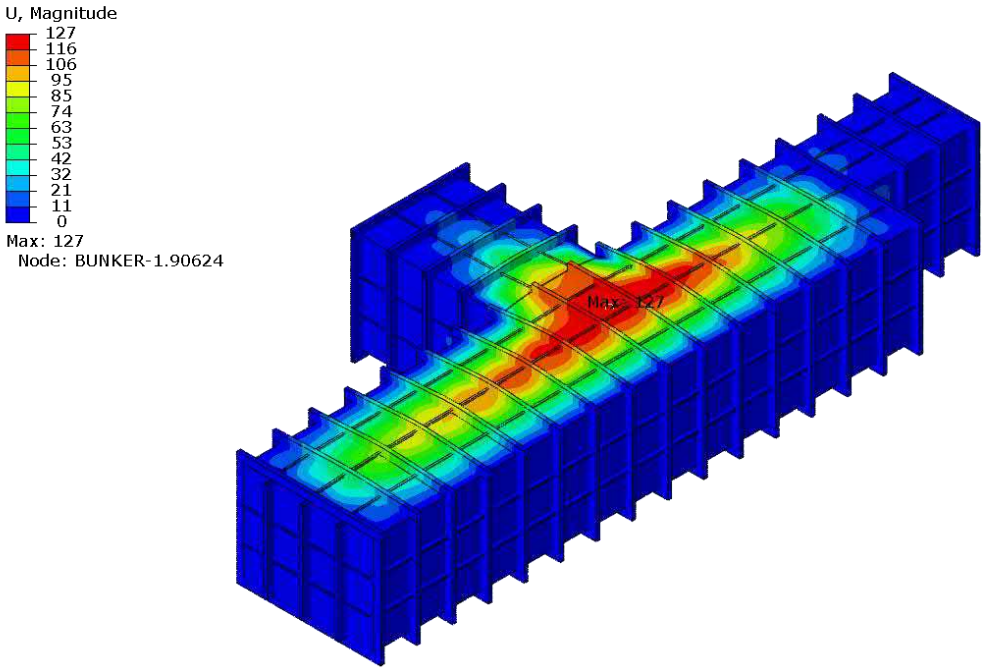


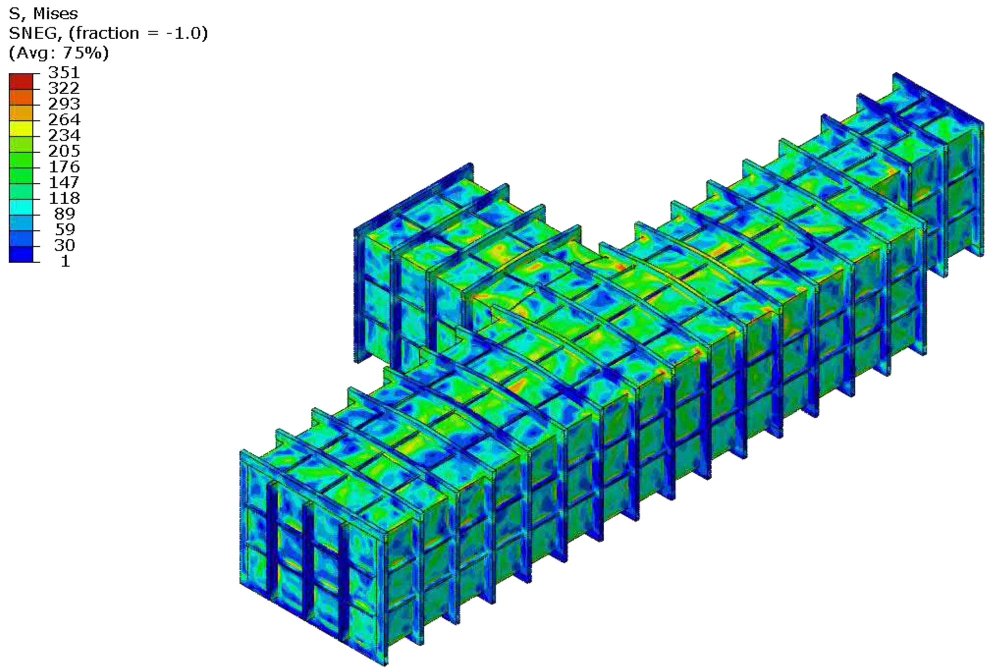
Sivil Sığınaklar



Sivil Sığınaklar

- *The deflection behavior obtained from the Abaqus Finite Element model (Displacement U) is shown together with the developed Von-Mises stresses.*
- *The FE model started to show similar deformation behavior to the actual bunker.*





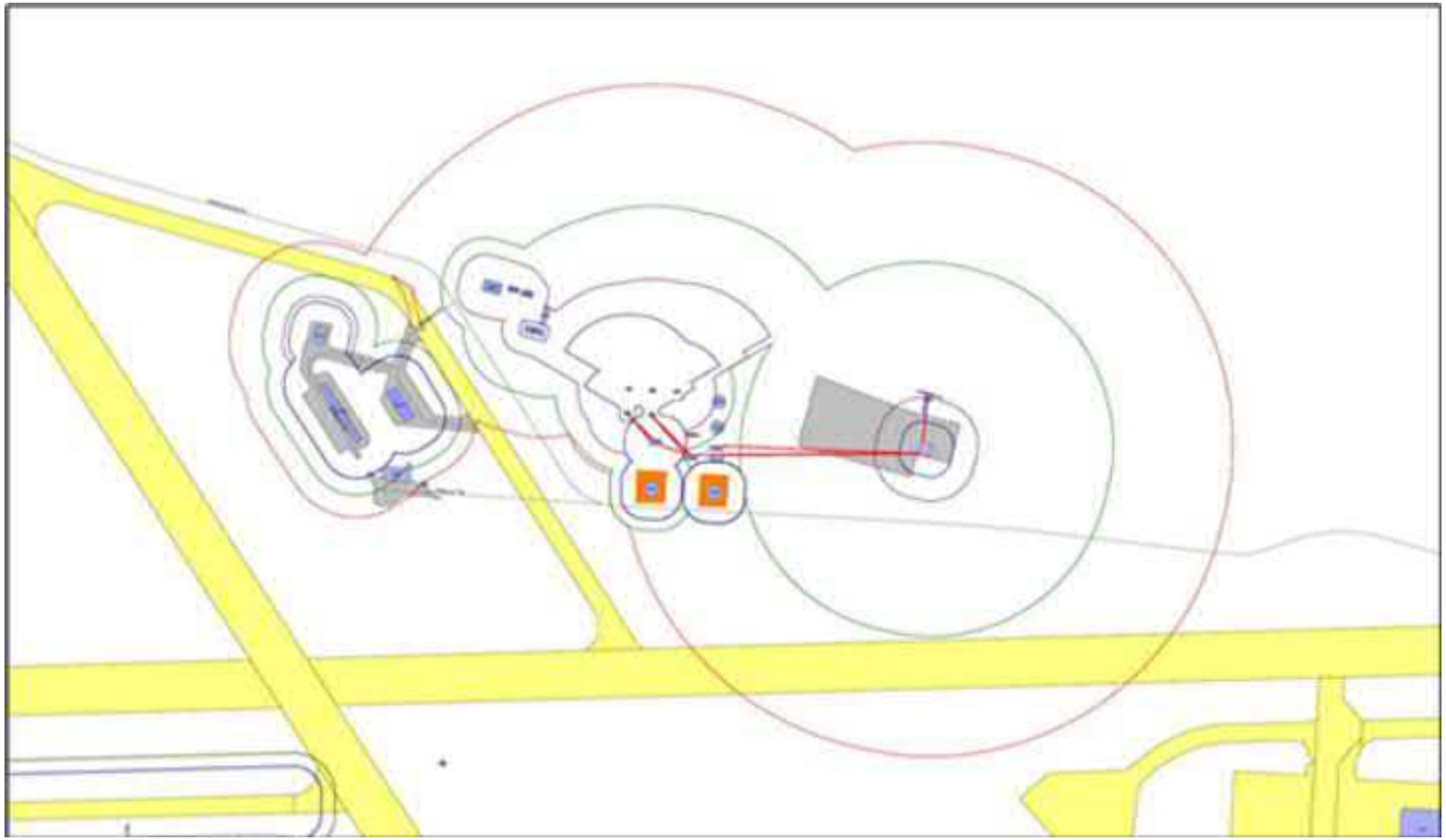
Mühimmat Üretim ve Depolama Tesislerinin Tasarımı

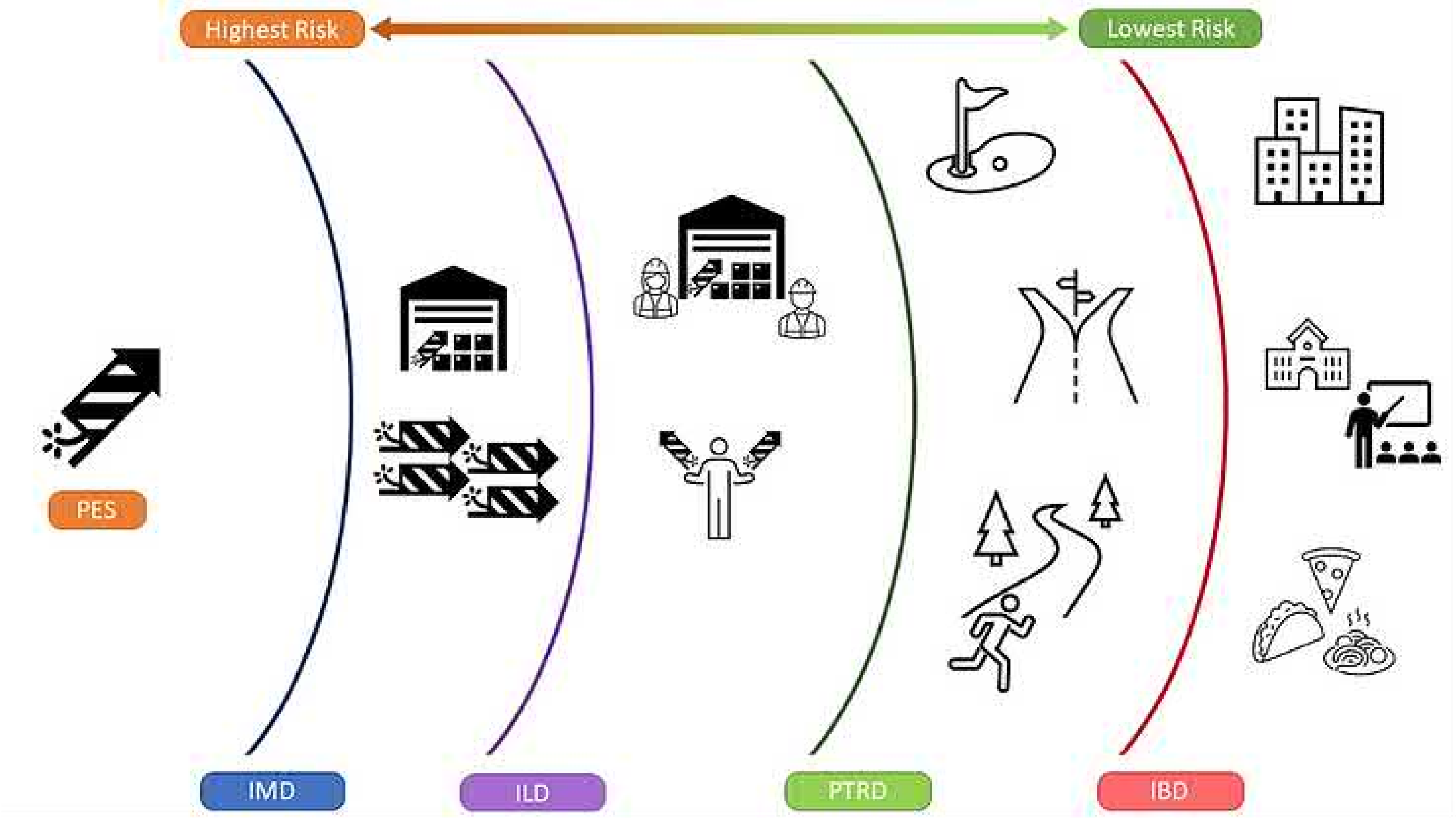
Mühimmat Üretim ve Depolama Tesisleri

Inhabited Building Distance (IBD)
Public Traffic Route Distance (PTRD)
Intraline Distance (ILD)
Intermagazine Distance (IMD)

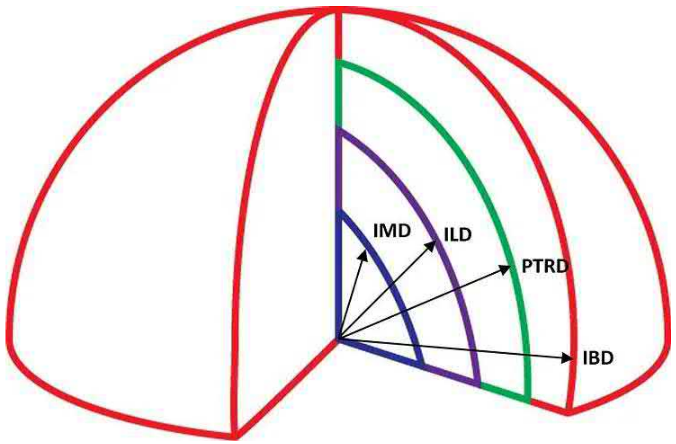
the DoD allows a maximum of 500,000 lbs. of explosives in a single storage location. The required IBD separation for 500,000 lbs 3,969 ft,

the general minimum IBD arc is 1,250 ft





Highest Risk
Lowest Risk
PES
IMD
ILD
PTRD
IBD



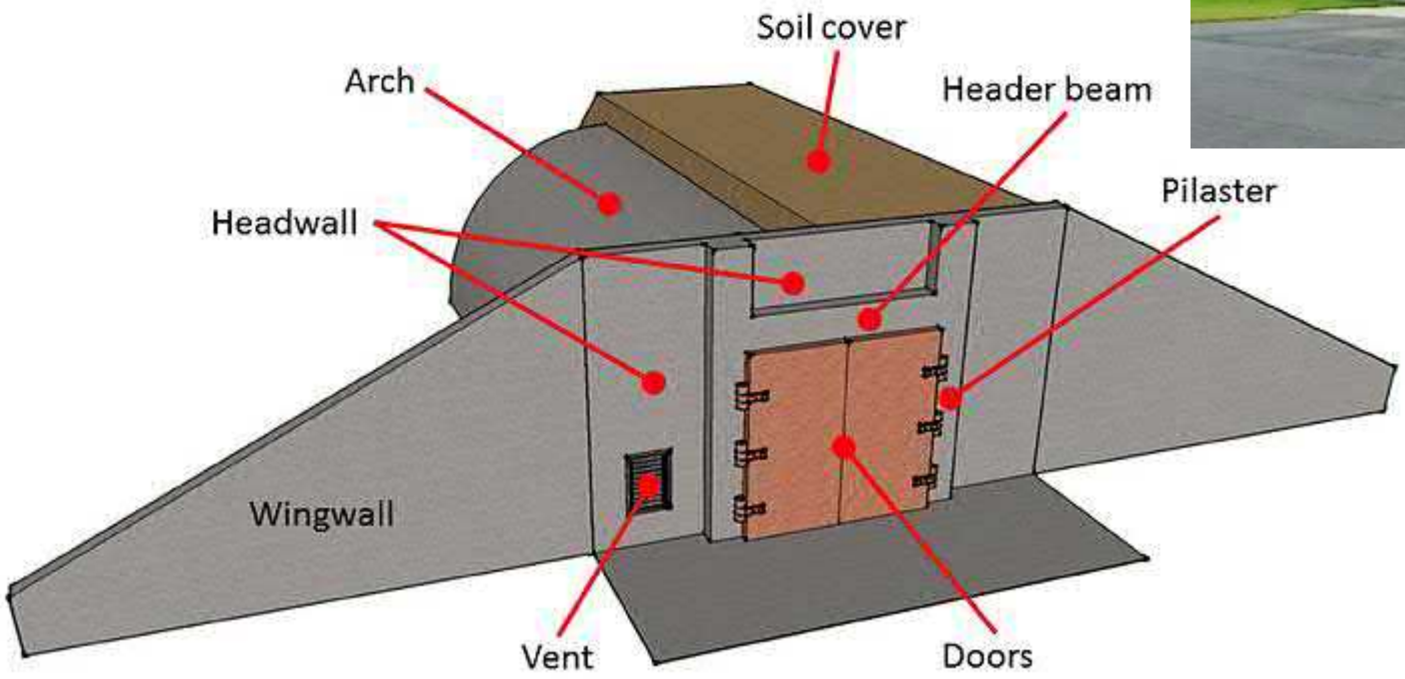
IMD
ILD
PTRD
IBD

Mühimmat Üretim ve Depolama Tesisleri

Exposure	K-Factor	Incident Pressure (psi)
IBD (<100k lbs)	40	1.2
PTRD (Public Traffic Route Distance) (<100k lbs)	24	2.3
Unbarricaded ILD (Intraline Distance)	18	3.5
Barricaded ILD	9	12
Unbarricaded IMD (Intermagazine Distance)	11	8
Barricaded IMD	6	27

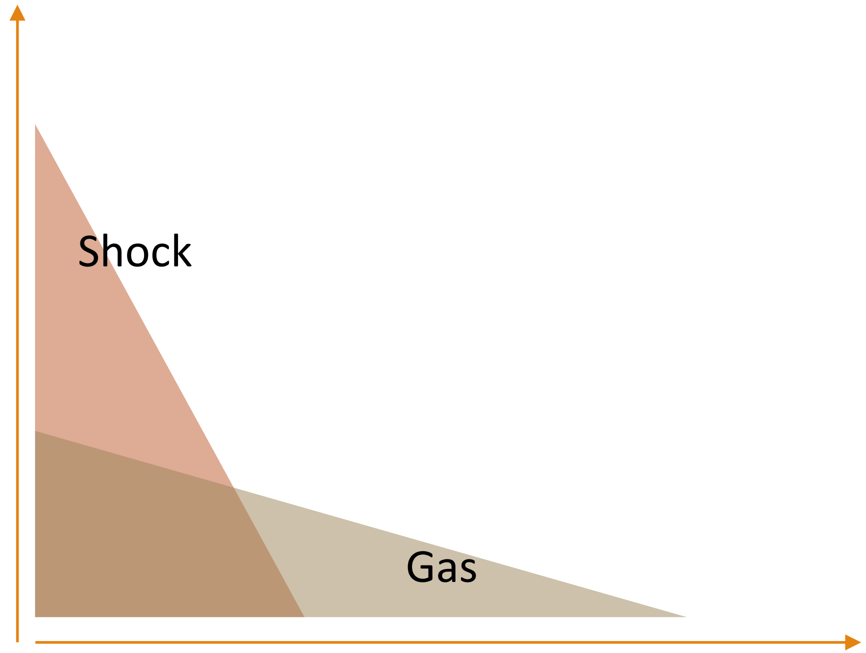
Explosive Weight (lbs)	K40 Distance (ft)
10	86
50	147
100	186
500	317
1,000	400
5,000	684
10,000	862
50,000	1,474
100,000	1,857

Mühimmat Depoları



Internal Building Blast Load Summary

For design, it is intended for the gas and shock loading to be used as a combined load curve.



Mühimmat Üretim ve Depolama Tesisleri

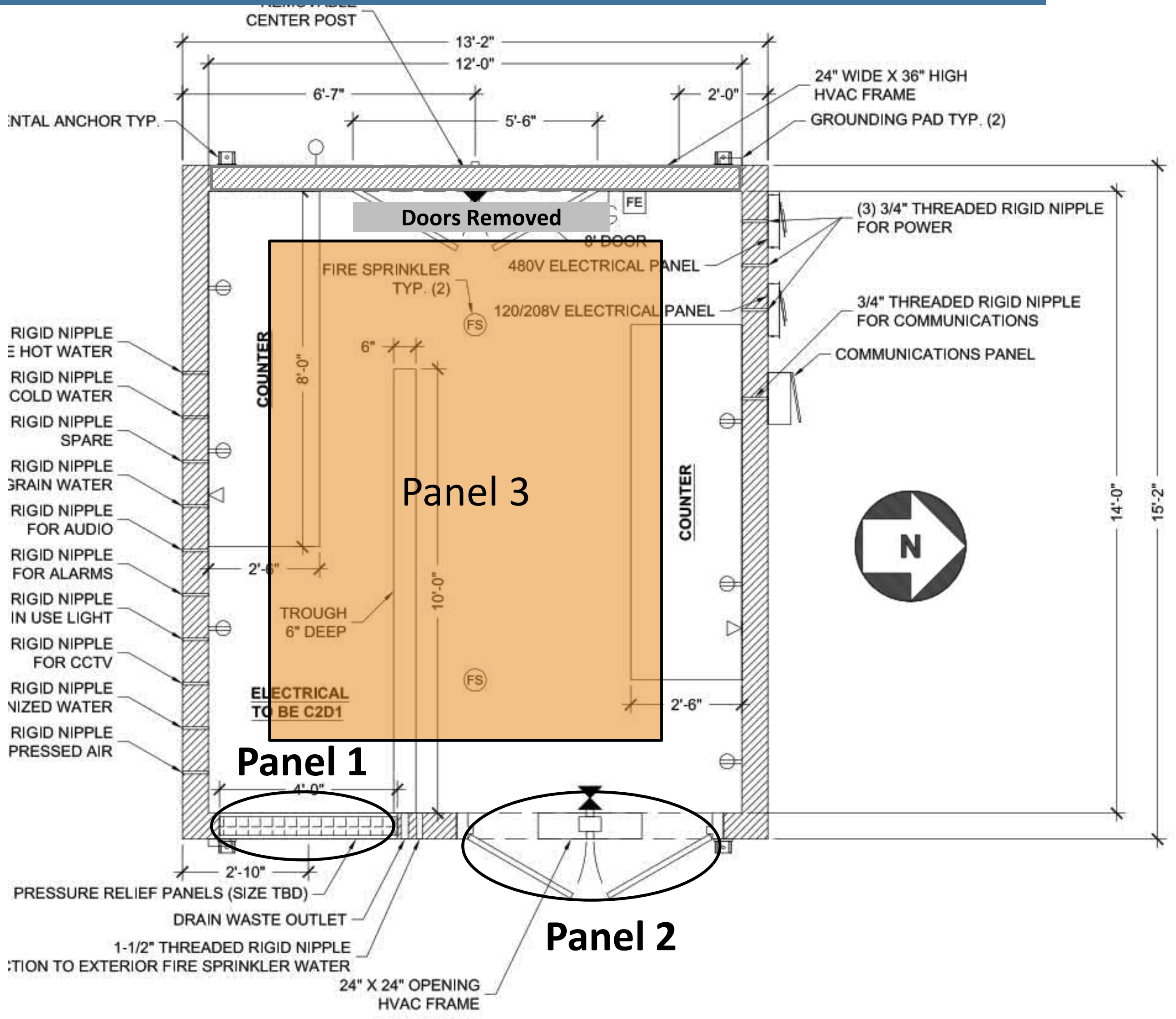
Inputs:

Room and Charge Inputs:

- Front Wall = West Wall
- Interior Room Dimensions (ft) – 14 Width X 24 Length X 11.5 Height
- Charge Weight = 33 lb_{TNT} X 1.2 = 39.6 lb
- Charge center 3 ft above floor and centered in plan dimensions
- Wall thickness = 7 inch (0.58 ft)
- Roof thickness = 6 inch (0.5 ft)

Vent Panel/Reduced Area Inputs:

- No open vent areas
- Three Vent Panels with all other surfaces assumed non-responding
- HVAC openings assumed non-responding
- Doors on west wall have been removed and entire west wall assumed non-responding
- Impulse loads on panels are from SHOCK results
- Panel 1:
    - Frangible panel with weight/area = 10 psf
    - Centered vertically on wall
    - Panel dimensions = 4 ft wide X 11 ft tall X 0.58 ft thick
    - Panel recessed within wall and of equal thickness = 7 in (0.58 ft)
    - Bottom close to ground, no bottom edge vent, all other sides are edge vents
- Panel 2:
    - Double Door= 5.5 ft wide X 7 ft tall
    - Weight/area = 22 psf
    - Door bottom at floor level , no bottom edge vent, all other sides are edge vents
    - Door thickness = 4 inch (0.33 ft) and flush with exterior
- Panel 3:
    - Roof Snow Load = 20 psf
    - Panel weight/area = 10 psf
    - Total Ceiling Panel weight/area = 30 psf
    - Panel area = roof area less 1 ft perimeter
    - Recessed within roof thickness = 6 in
    - All sides are edge vents



Patlayıcıların Tehlike Sınıfları

1.1 – Mass Detonating: bulk explosives, some propellants, mines, bombs, and large artillery rounds

1.2 – Nonmass-detonating, Fragment-producing: smaller artillery rounds, other weapons

1.3 – Mass Fire: only explosion is rupture of containers

1.4 – Moderate Fire, No Blast

1.5 & 1.6 – Very low probability of explosion

Specific rules apply to combining weights

Güvenlik Belgeleri Q-D Yaklaşımı

Quantity-Distance is actually a scaled range

Expressed as a separation distance = $R/W^{1/3}$

Typical separation distances (HD 1.1):

- 6 $W^{1/3}$ (27 psi)– Barricaded magazines
- 11 $W^{1/3}$ (8 psi) – Unbarricaded magazines
- 30 $W^{1/3}$ (1.7 psi) – Public traffic routes
- 40 $W^{1/3}$ (1.2 psi) – Inhabited buildings

Minimum separation distances also apply for fragment protection

Closer distances permitted if supported by analysis

Ne Kadar Güvenli?

Criteria based on 1.1 type explosives

Independent of impulse – peak pressure only

Text in manuals based on some historical data

- Vehicles were heavier with thicker steel body panels
- Building construction was heavier

Interpret information on the next slide with caution – just because a building code allows it does not make it a good idea!

Ne Kadar Güvenli?

At 27 psi (6 $W^{1/3}$) – conventional unstrengthened buildings are destroyed, serious eardrum and lung damage among survivors, vehicles severely damaged

At 12 psi (9 $W^{1/3}$) – Unstrengthened buildings will be severely damaged, people exposed at the site will be severely injured, vehicles heavily damaged

At 3.5 psi (18 $W^{1/3}$) – building damage approximately 50% of replacement cost, 1% eardrum damage, vehicle body panels damaged, vehicle windows cracked

At 2.3 psi (24 $W^{1/3}$) – building damage 20% of replacement cost

At 1.7 psi (30 $W^{1/3}$) – building damage 10% of replacement cost

At 1.2 psi (40 $W^{1/3}$) – building damage 5% of replacement cost

Per DoD 4125.26M Contractors' Safety Manual

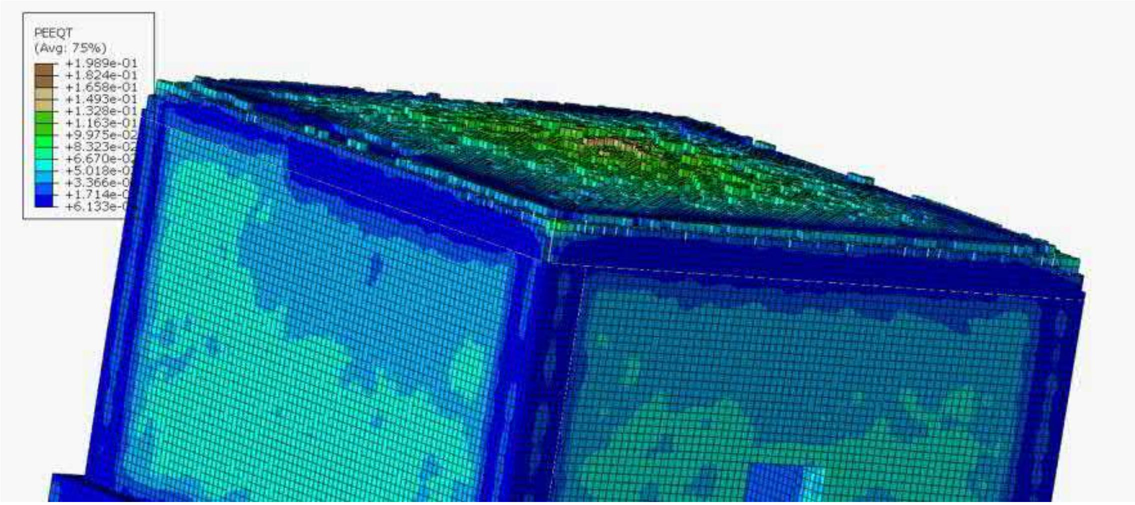
Patlayıcı Güvenliği Özeti

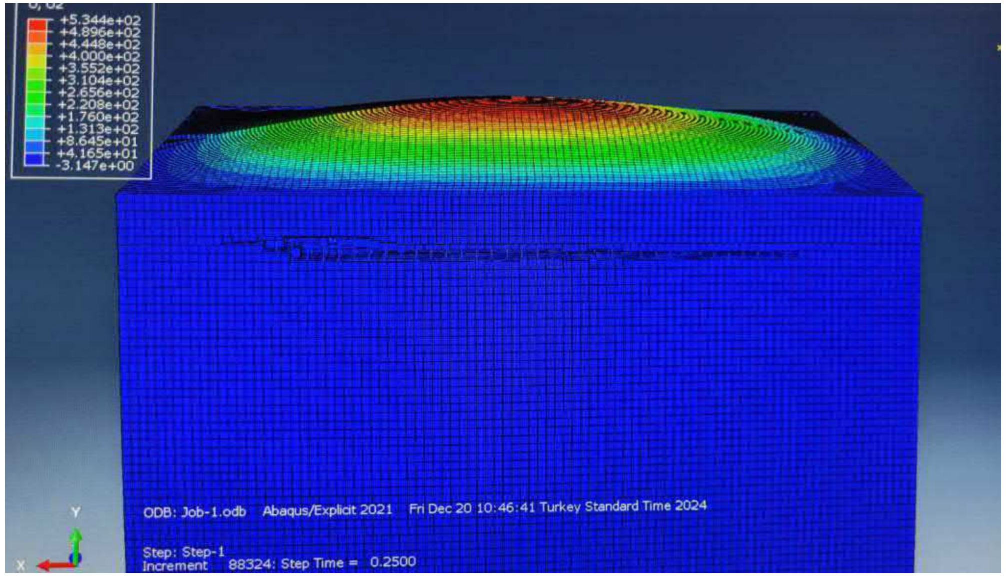
Regulations are the minimal requirements

Significant damage and injury can occur at “Permitted Distances”

Standards do not address internal blasts other than for assembly line distances

Bina içi Patlamalar



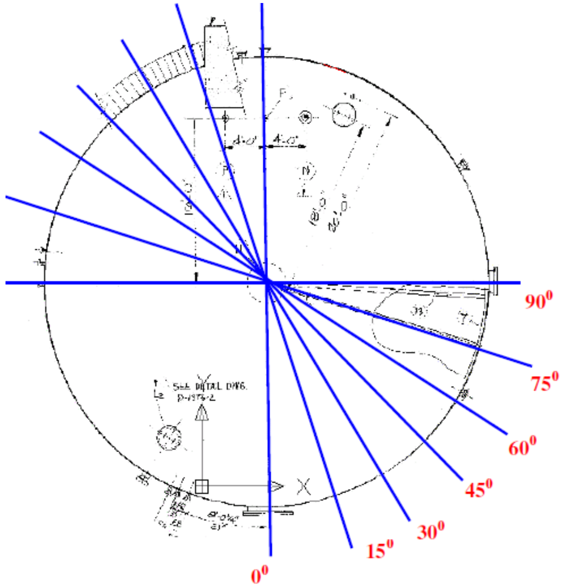


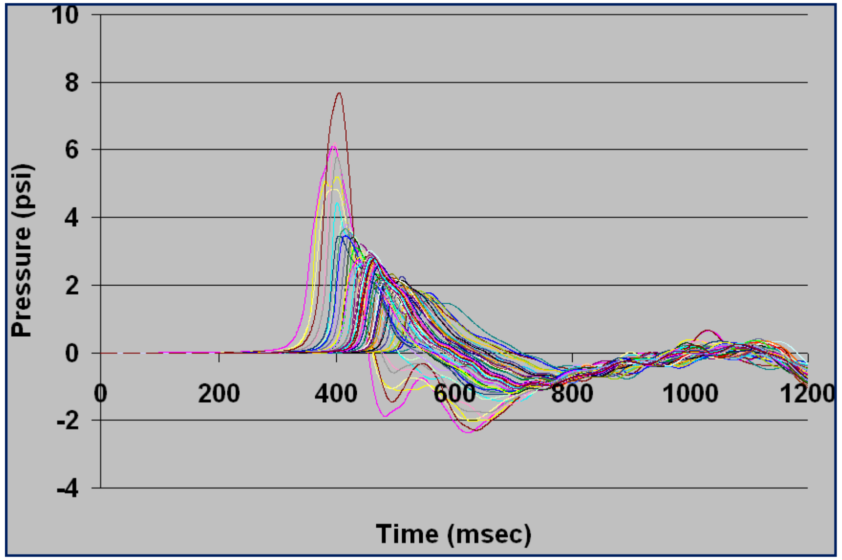
Bina içi Patlamalar

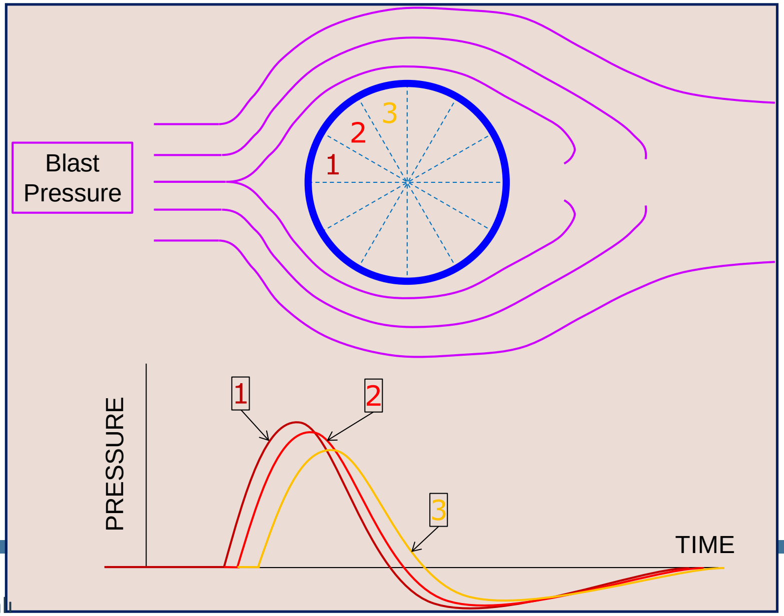
Borular ve Depolama Tankları

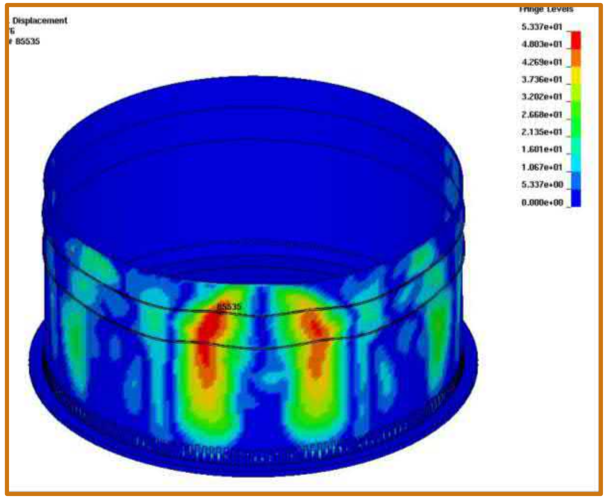
Borular ve Depolama Tanklarının Davranışı

Borular ve Depolama Tanklarının Davranışı



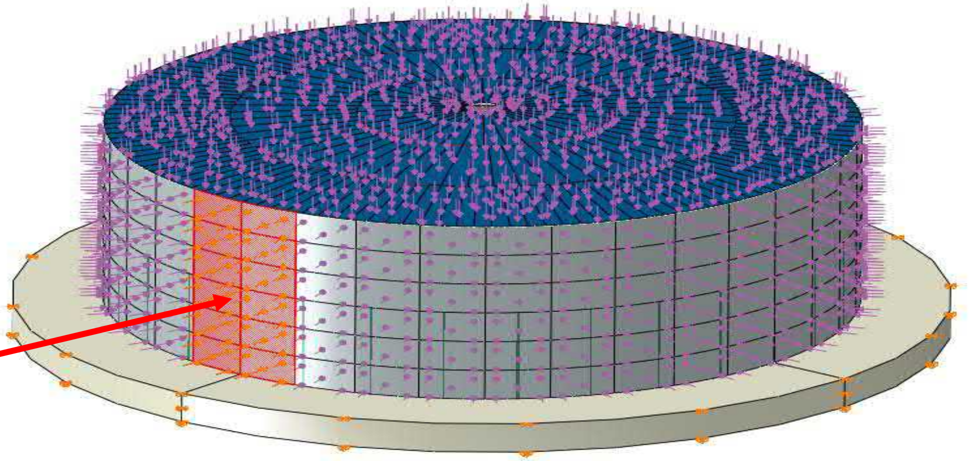


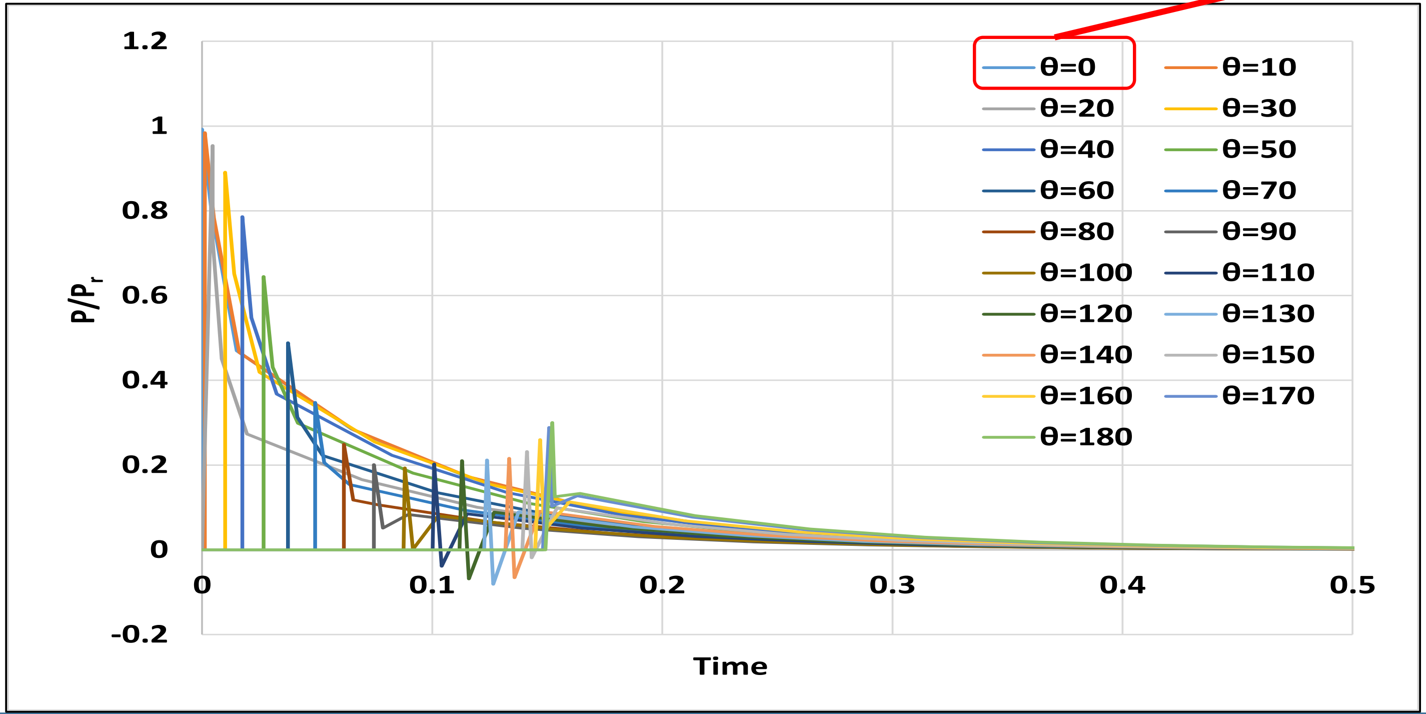


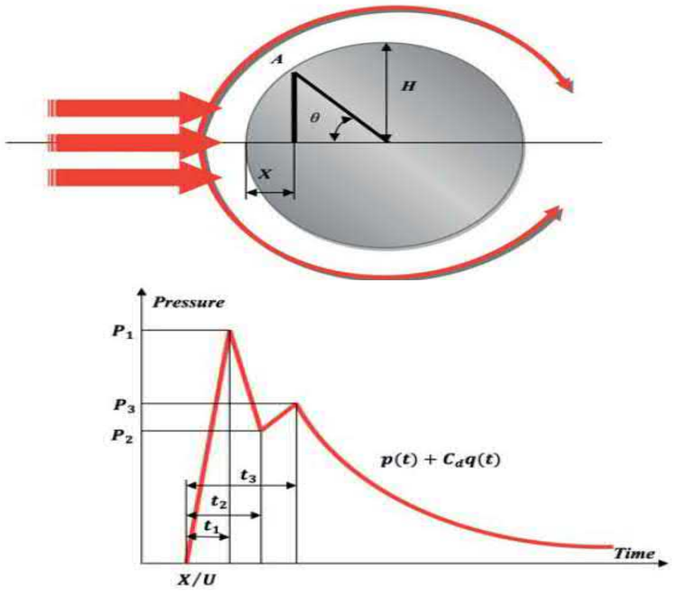


Borular ve Depolama Tanklarının Davranışı

P= 0.15 bar - 0.70 bar
Tank type, H/D ratio and liquid level







Yasseri (2015)

Borular ve Depolama Tanklarının Davranışı

Drag load versus blast overpressure effects

$$F_D = \frac{1}{2}\,\rho\,A\,C_d\,|v|v$$

Nonlinear Material Model

Effects of Non-Structural Masses and Adjacent Piping Systems

$$F_D = C_d\,P_d\,OD$$

Pipe Supports

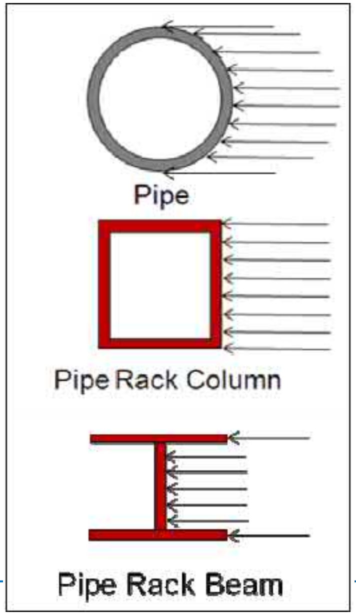
Flange Failure

Effects of Operating Temperature on Material Properties

Blast direction/Ignition location sensitivity

Effects of Shielding

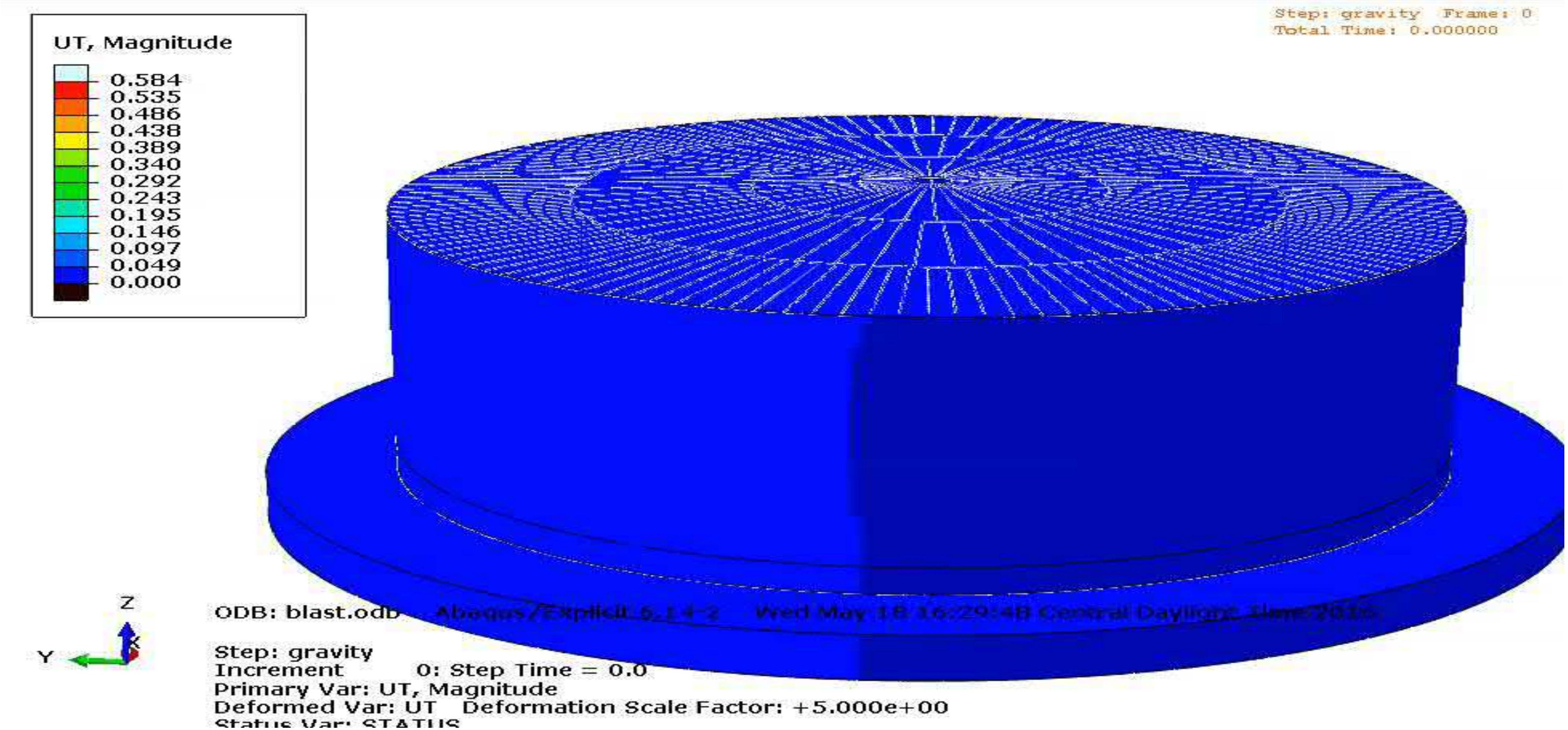
Effects of Pipe Insulation



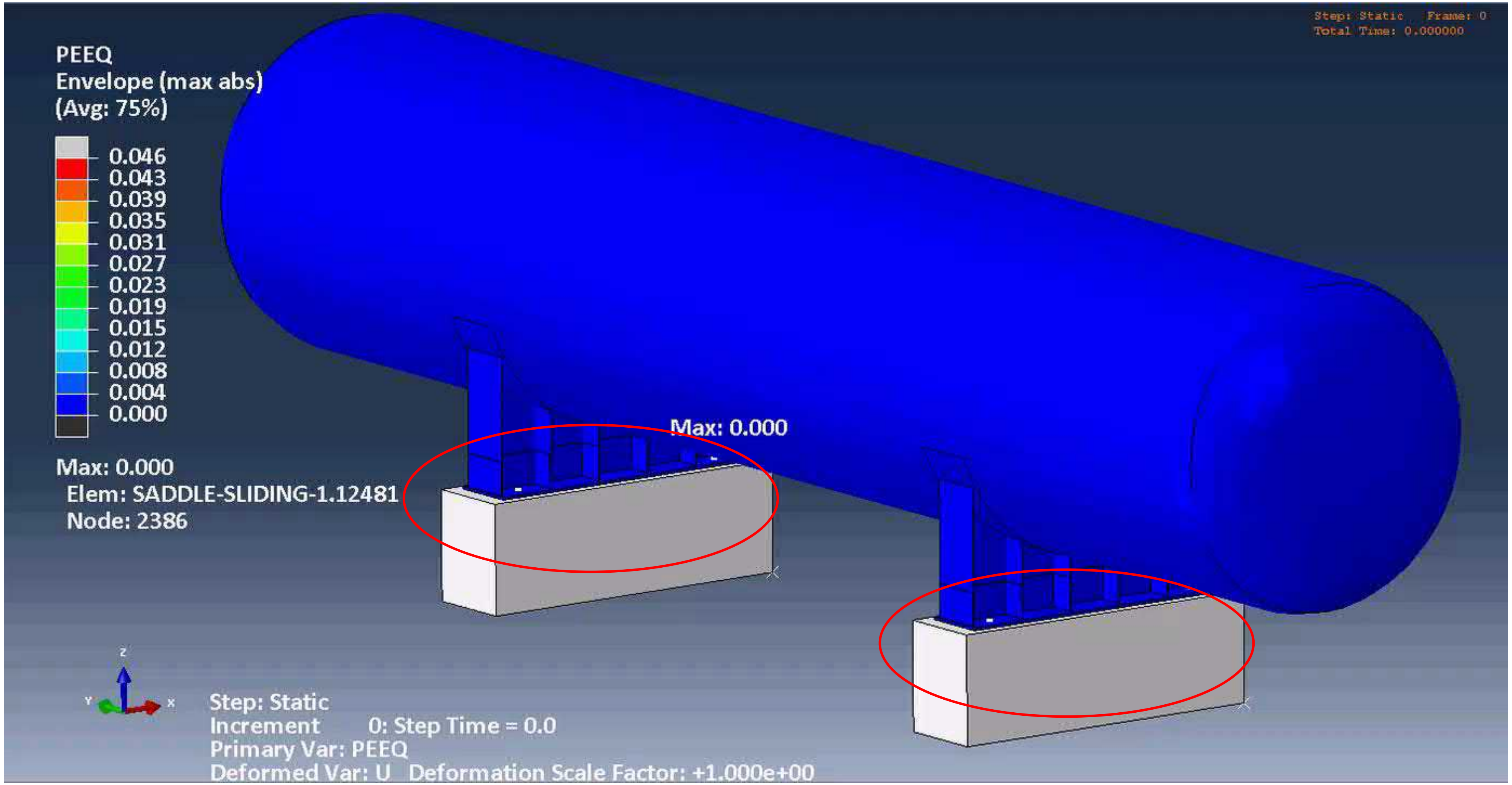
Depolama Tanklarının Davranışı

Deformation response (m):

P_s=3.5 psi (24 kPa), t_d=0.5 sec

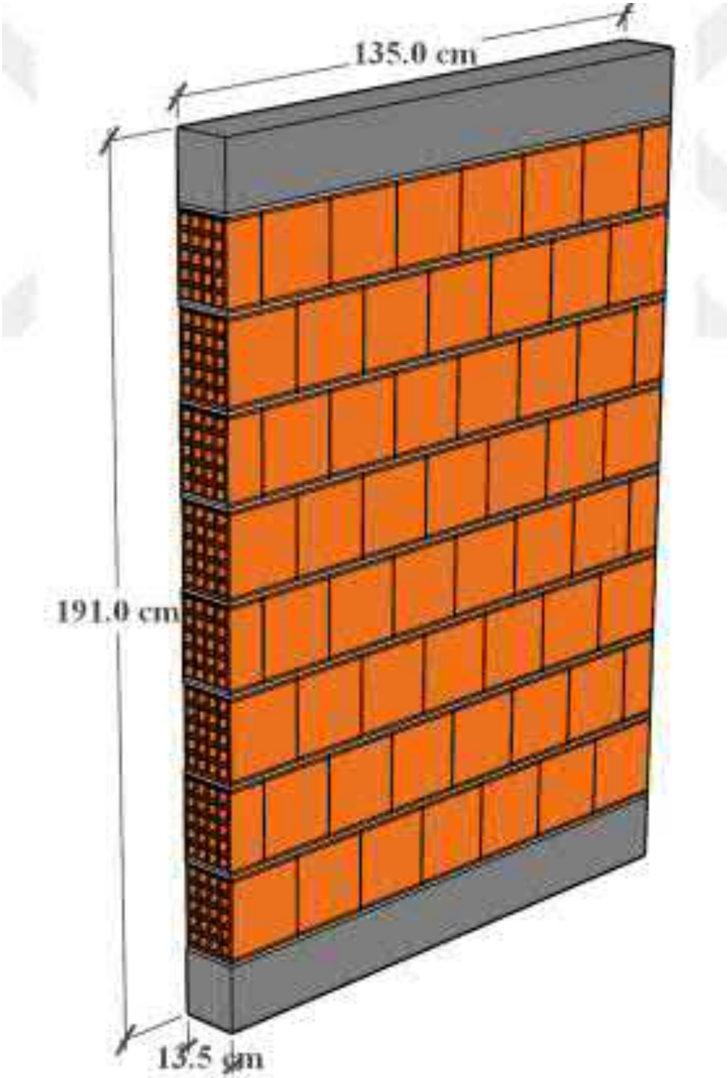


Blast Response of Pressure Vessel – Blast Load = 0.6 bar with 200 msec



Duvar Güçlendirme Yöntemleri

Duvar Güçlendirme Yöntemleri



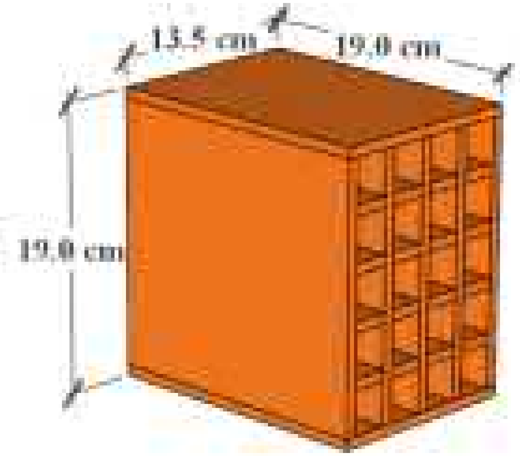
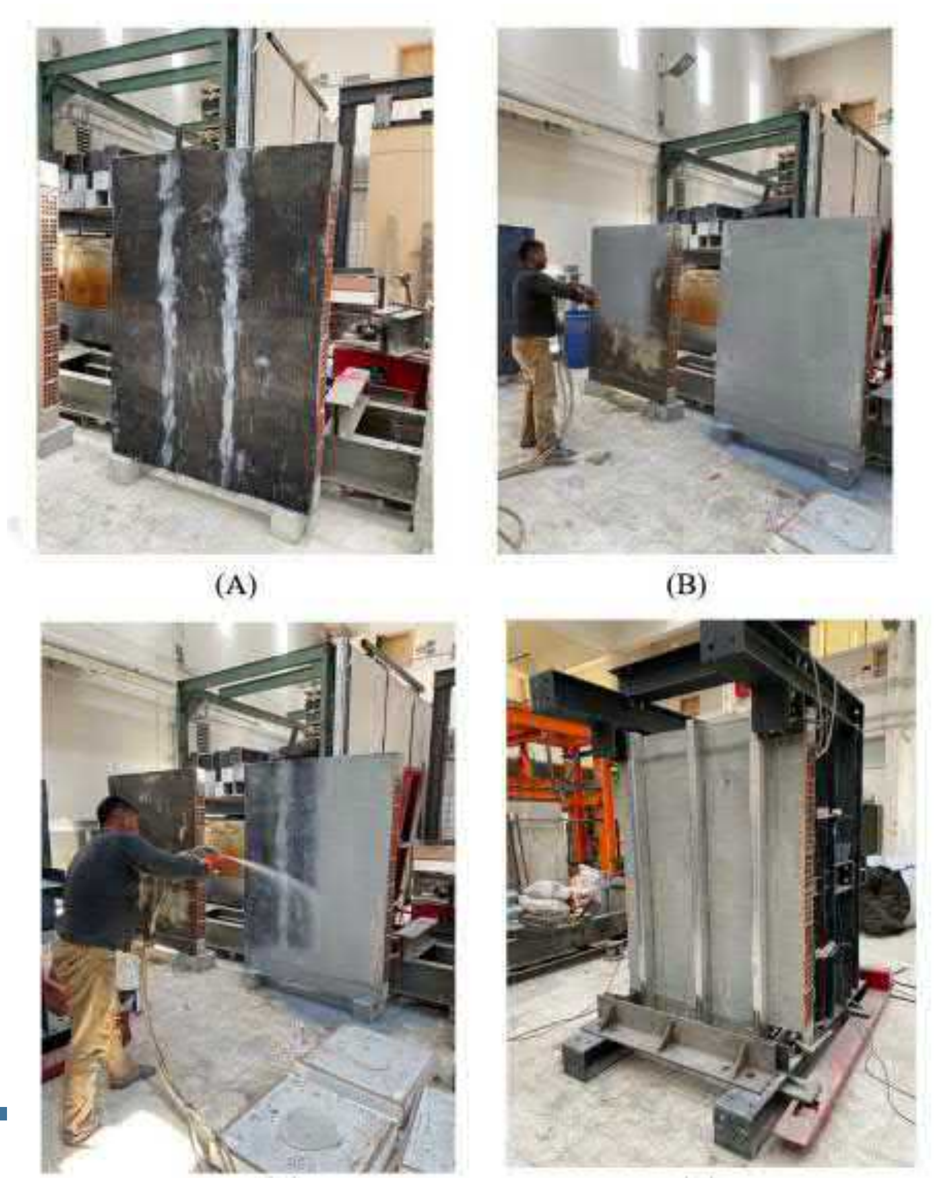


Table 2.1 : Masonry Infill Walls Retrofitting Materials

Series	Wall specimen	umber
1	Reference wall	6
2	Cement plaster	4
3	CFRP	2
4	Polyurea Spray	2
5	CFRP + Polyurea Spray	2
6	Aluminum stiffener	2

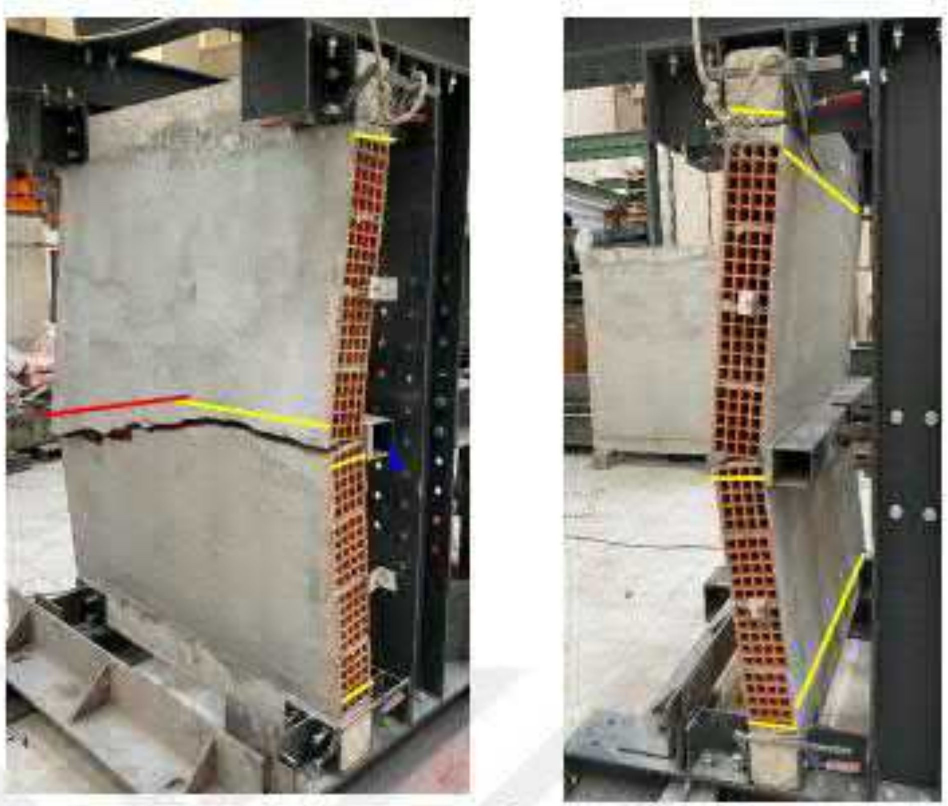
Duvar Güçlendirme Yöntemleri



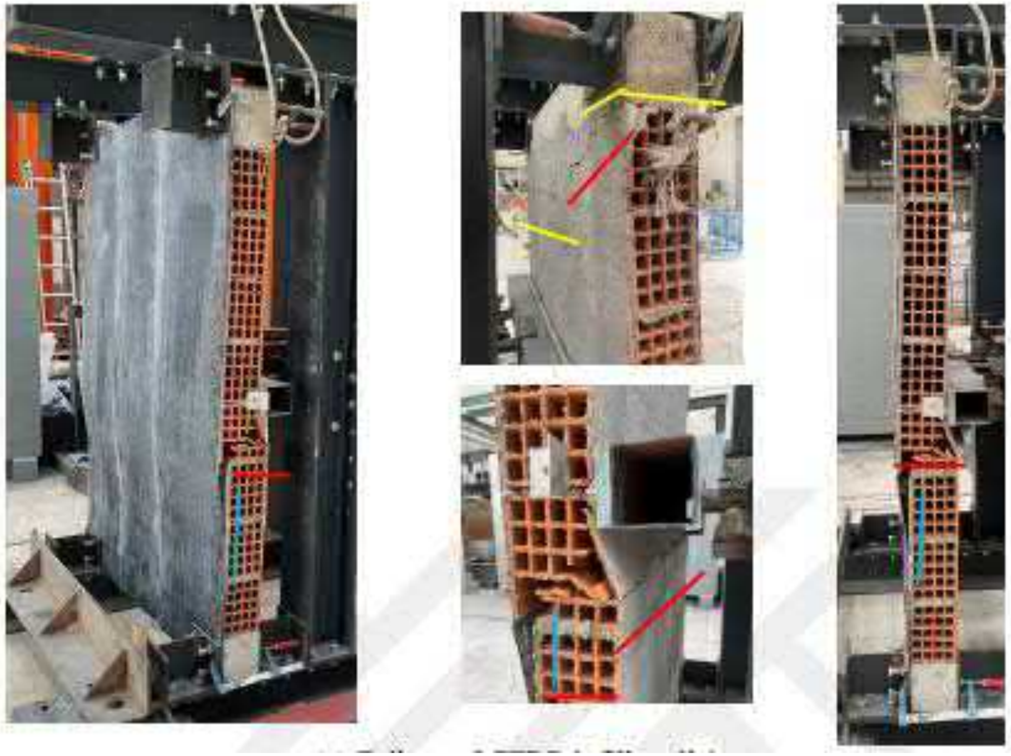
-Karbon Fiber Takviyeli
-Polyurea Sprey
-Çimento Sıvası
-Aluminyum Takviye Elemanı

Duvar Güçlendirme Yöntemleri

(a) Thick layer cement plaster infill wall 1.



(c) Thin layer cement plaster infill wall 1.



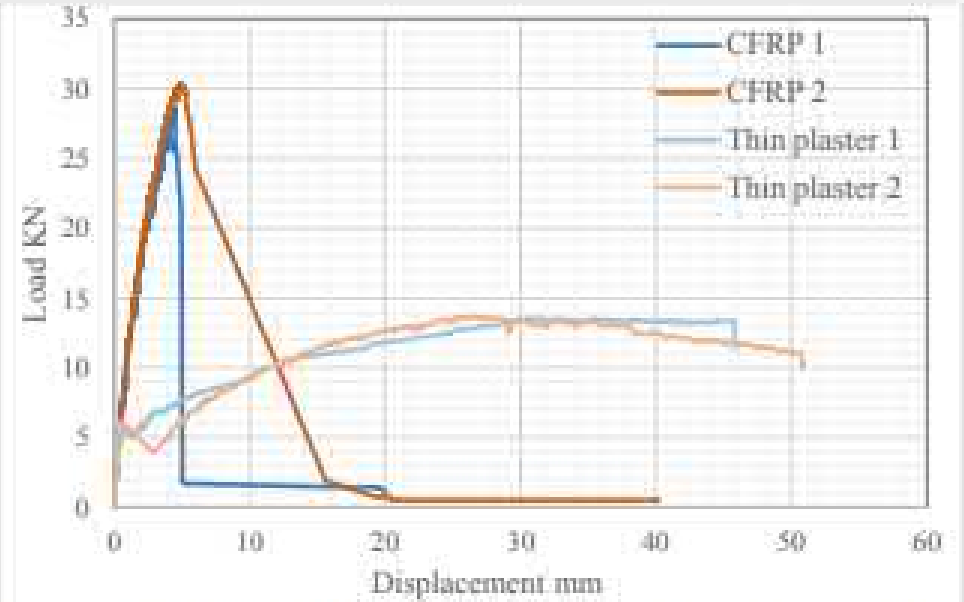
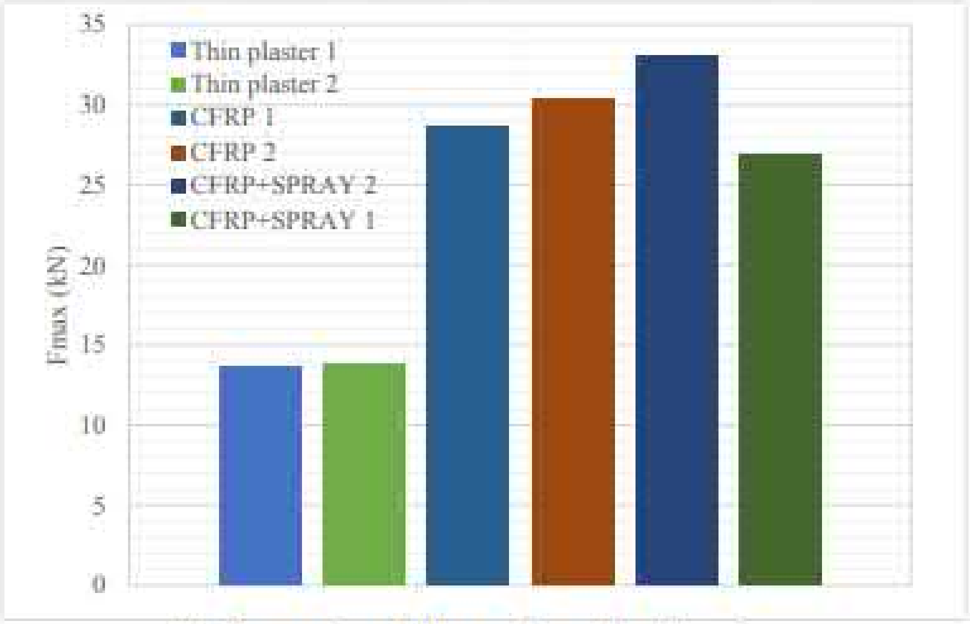


Figure 4.15 : Comparison of the Load-displacement Curve of CFRP Retrofitted Infill Walls with Un-retrofitted Walls.

Duvar Güçlendirme Yöntemleri

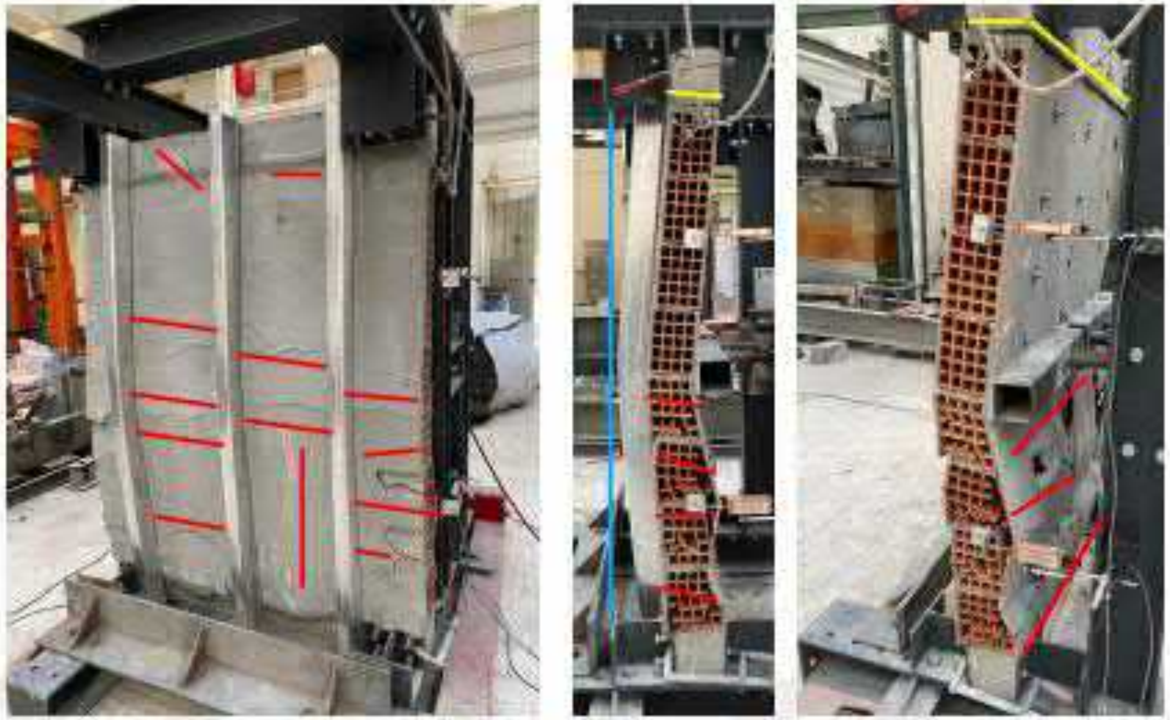
Figure 4.22 : Retrofitted Infill wall with Polyurethane Spray and CFRP Layers.



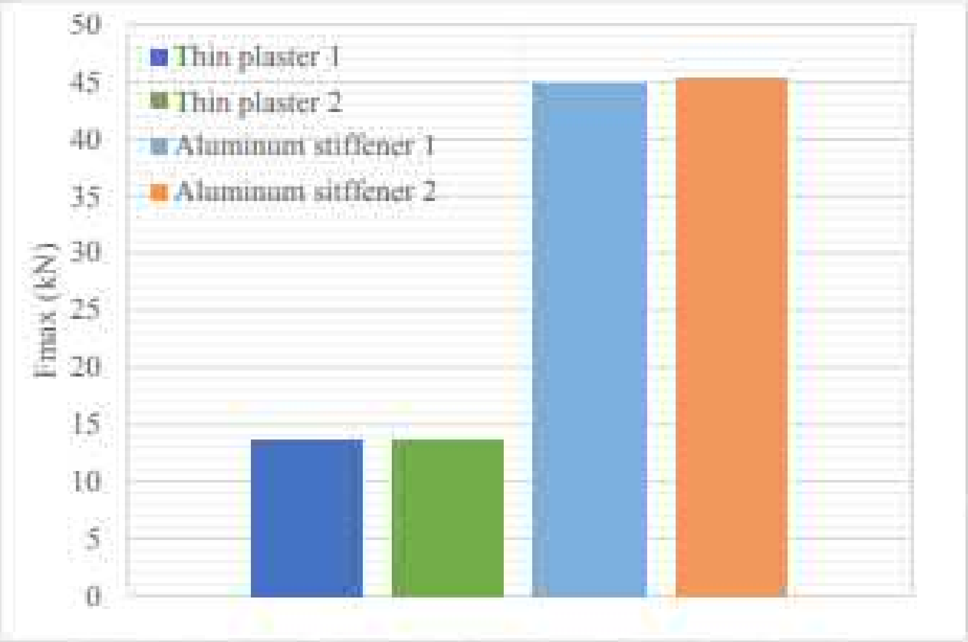
(a) Comparison of the maximum load-bearing.

Figure 4.25 : Comparison Response of the CFRP, CFRP+Polyurea Spray and Un-retrofitted (Thin Layer) Infill Walls.

Duvar Güçlendirme Yöntemleri



(a) Aluminum stiffener 1.



(a) Comparison of the maximum load-bearing.

Duvar Güçlendirme Yöntemleri

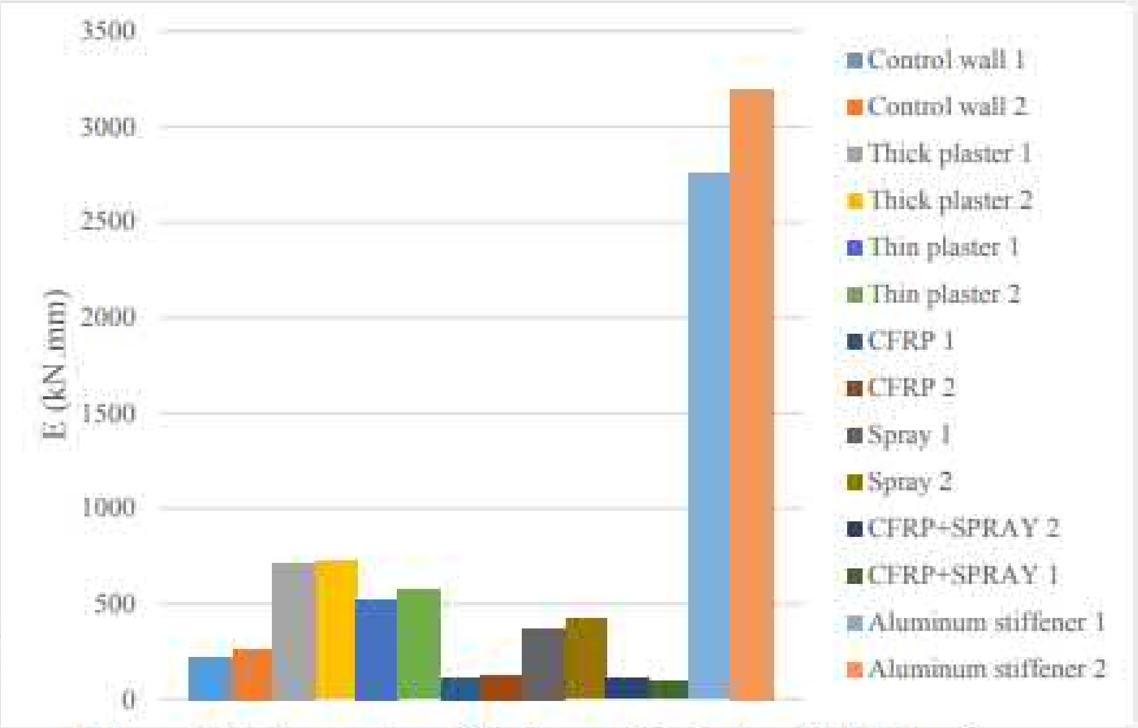


Figure 4.31 : Comparison of the Energy Dissipation of Each Specimen.

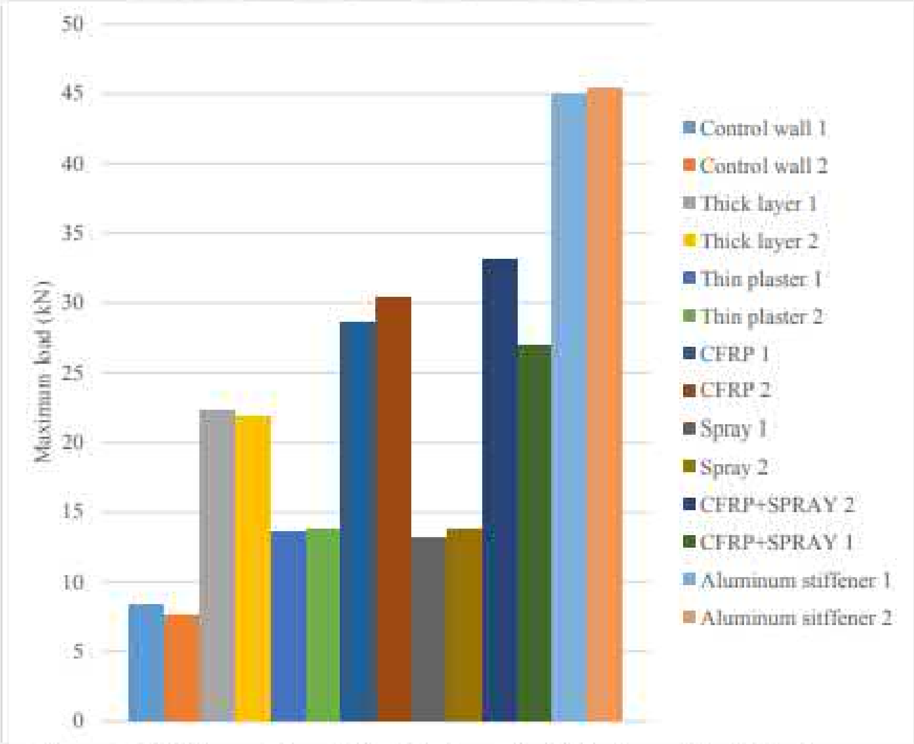
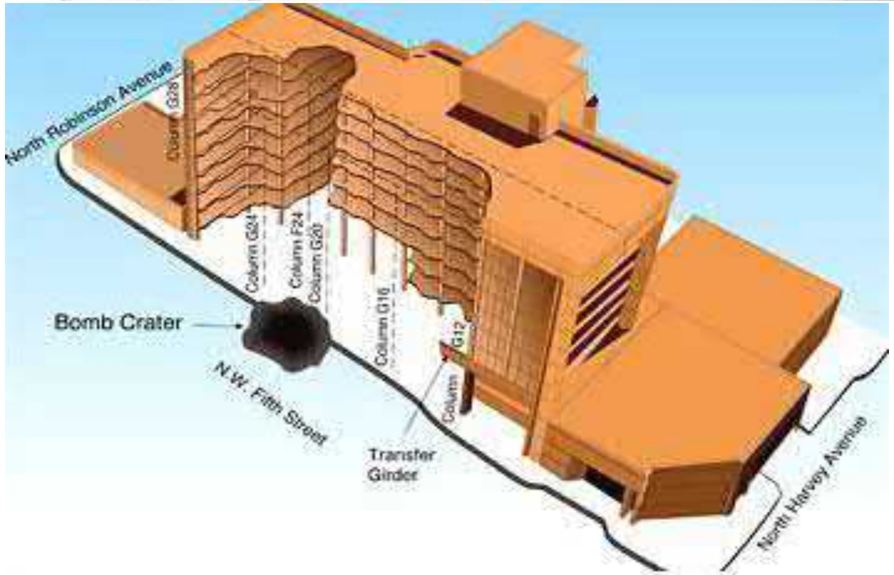


Figure 4.32 : Comparison of the Maximum Load Bearing of Each Specimen.

Progressive Collapse Analizi

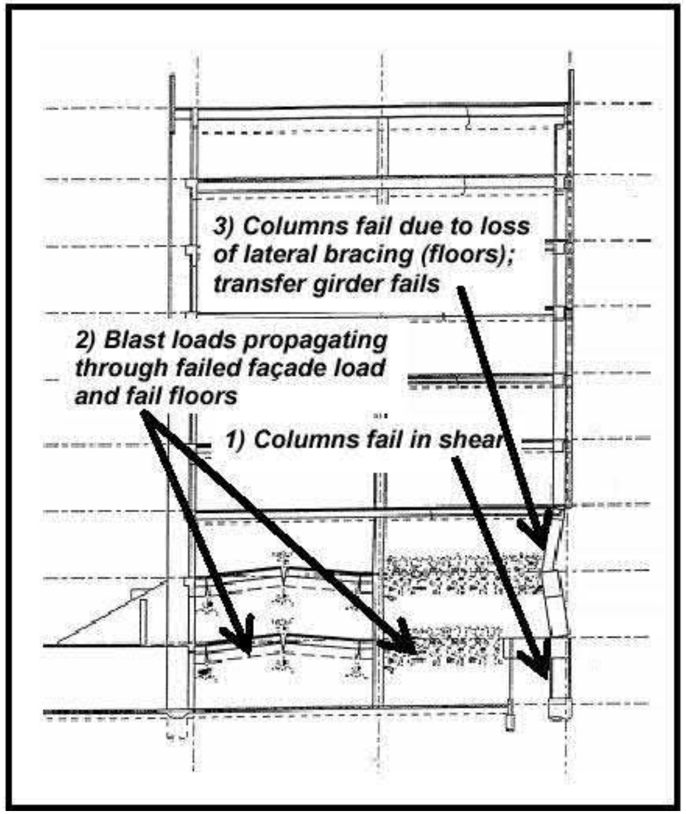
Alfred P. Murrah Federal Binası Bombalı Saldırısı

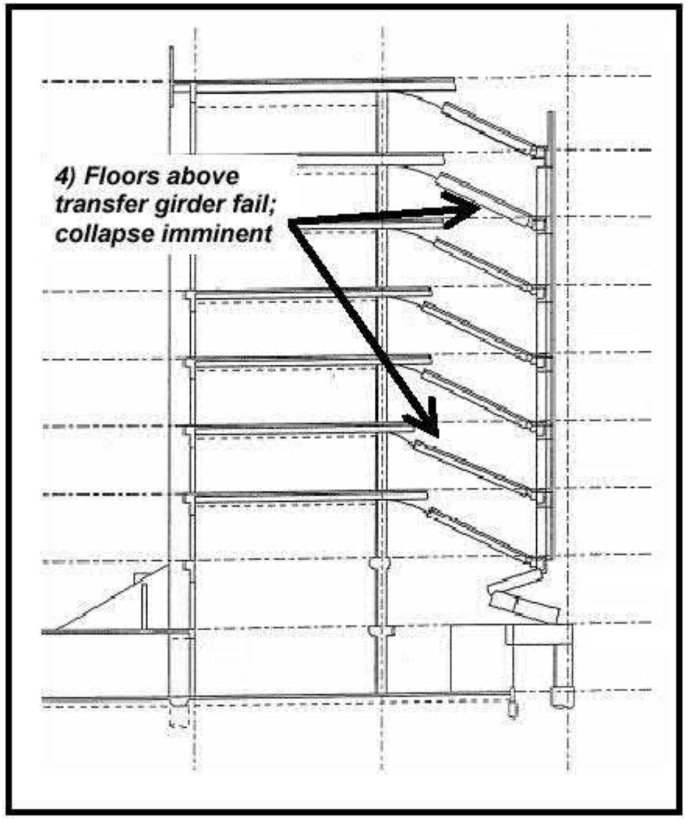


Failure boundaries of roof/floor slabs in the Murrah Building.

- 1995 – 9 Story Alfred P. Murrah Federal Building was attacked with truck bomb.
- Blast from approximately over 5,000 pounds (2,300 kg) of equiv. TNT destroyed one of the perimeter concrete columns and caused brittle failure of 2 others
- Transfer girder above damaged columns failed allowing collapse of upper floors
- 168 people were killed and 680 more injured.
- Nearly 90% of fatalities were from the collapse of the structure
- Studies of the disaster suggests that use of ductile detailing could have reduced extent of damage

Alfred P. Murrah Federal Binası Bombalı Saldırısı

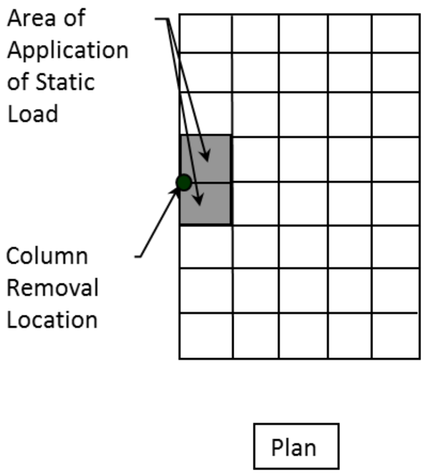


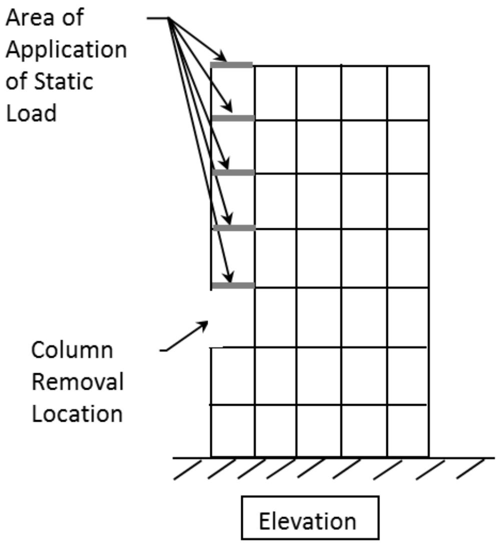


Progressive Collapse Analiz Yöntemleri

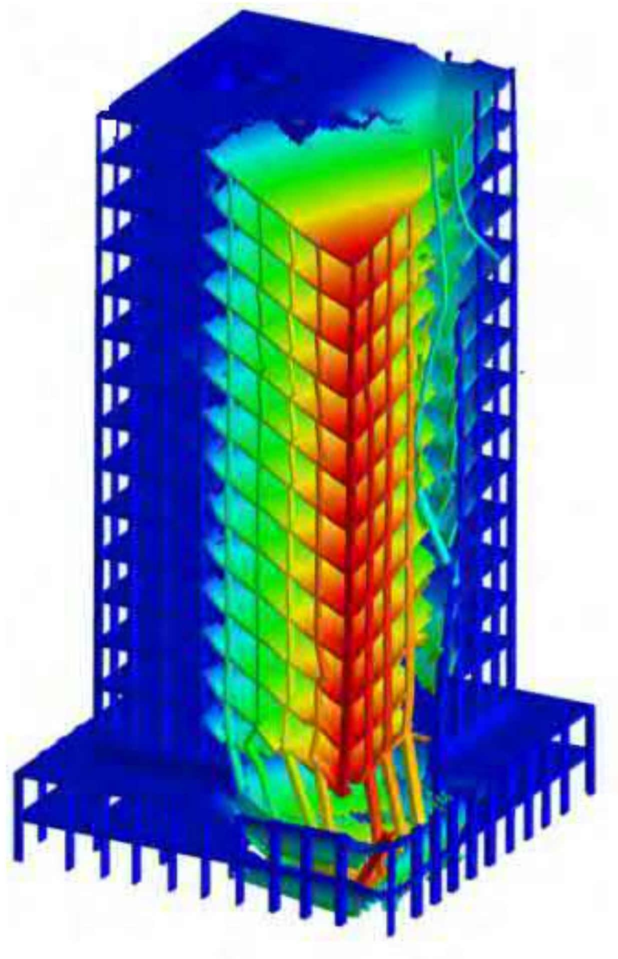
The direct method

- Specific Local Resistance Method, key structural members are intentionally hardened to resist a clearly defined threat.
- Alternate Load Path Method allows for local damage but seeks to provide alternate load path to ensure that the major damage is averted





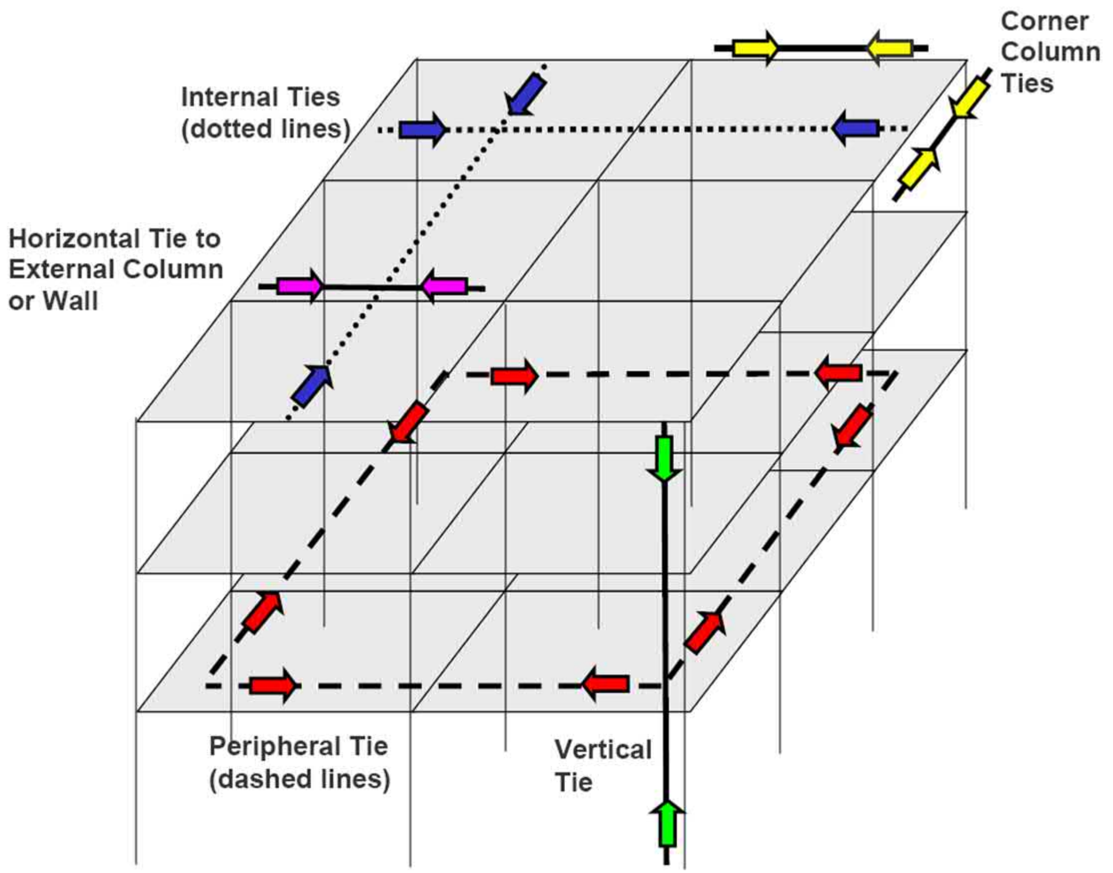
Alternate Load Path Method



Applied Element Method

Progressive Collapse Analiz Yöntemleri

The indirect method (tie method) requires that effective ties be provided within the building without any explicit means of assessing or quantifying the potential of collapse



Progressive Collapse Analiz Yöntemleri

Indirect method

- Requires better detailing and some additional reinforcement to provide alternative load paths in case of load-bearing component failure

Direct method assuming column or bearing wall failure

- Designs alternative load paths into surrounding building components

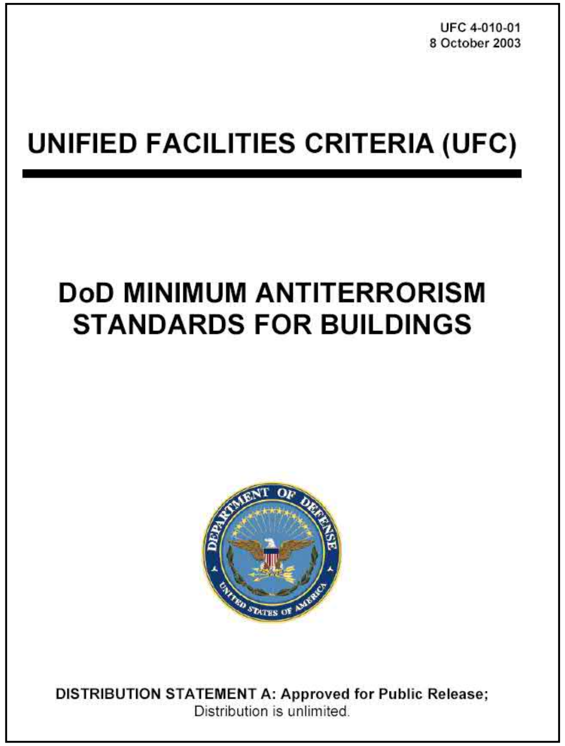
Direct method to design columns or bearing walls to resist specified threat without failing

Choice of design approach depends on numerous considerations

- Perceived risk of building to unexpected loading
- Confidence level in a defined design threat
- Building importance to owner
- Building occupancy

Progressive Collapse Analiz Yöntemleri

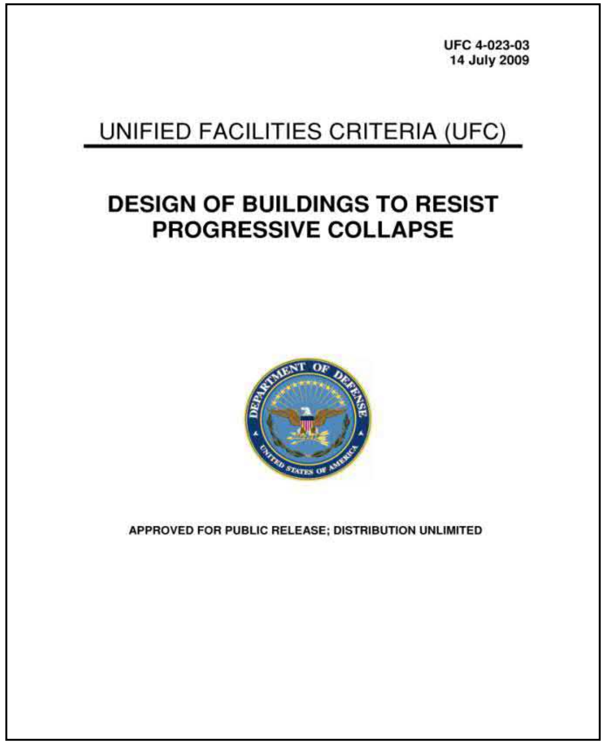
Both the UFC and GSA progressive collapse requirements use a combination of indirect and direct methods to achieve their respective goals of designing sufficiently robust structures and increasing the probability that these structures will exhibit a low potential for progressive collapse.


UFC 4-010-01
8 October 2003

UNIFIED FACILITIES CRITERIA (UFC)

DoD MINIMUM ANTITERRORISM STANDARDS FOR BUILDINGS

DISTRIBUTION STATEMENT A: Approved for Public Release;
Distribution is unlimited.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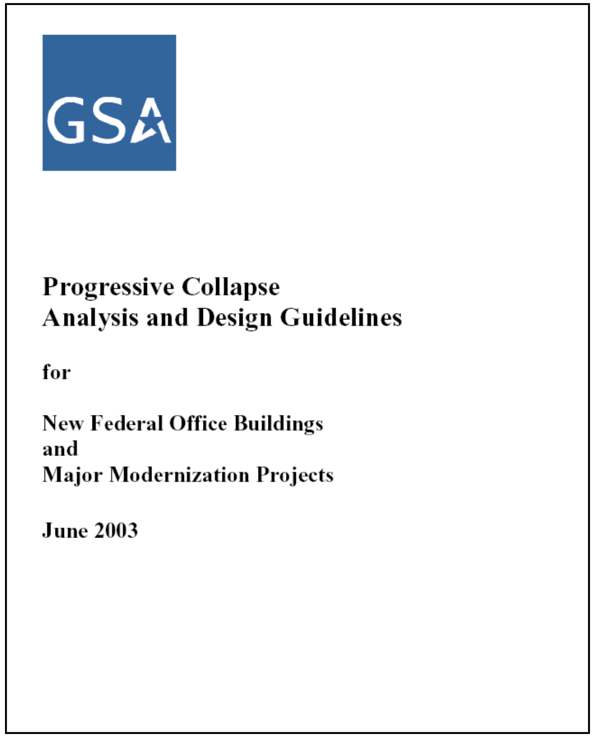
UNIFIED FACILITIES CRITERIA (UFC)

DESIGN OF BUILDINGS TO RESIST PROGRESSIVE COLLAPSE

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED


GSA

Progressive Collapse
Analysis and Design Guidelines

for

New Federal Office Buildings
and
Major Modernization Projects

June 2003

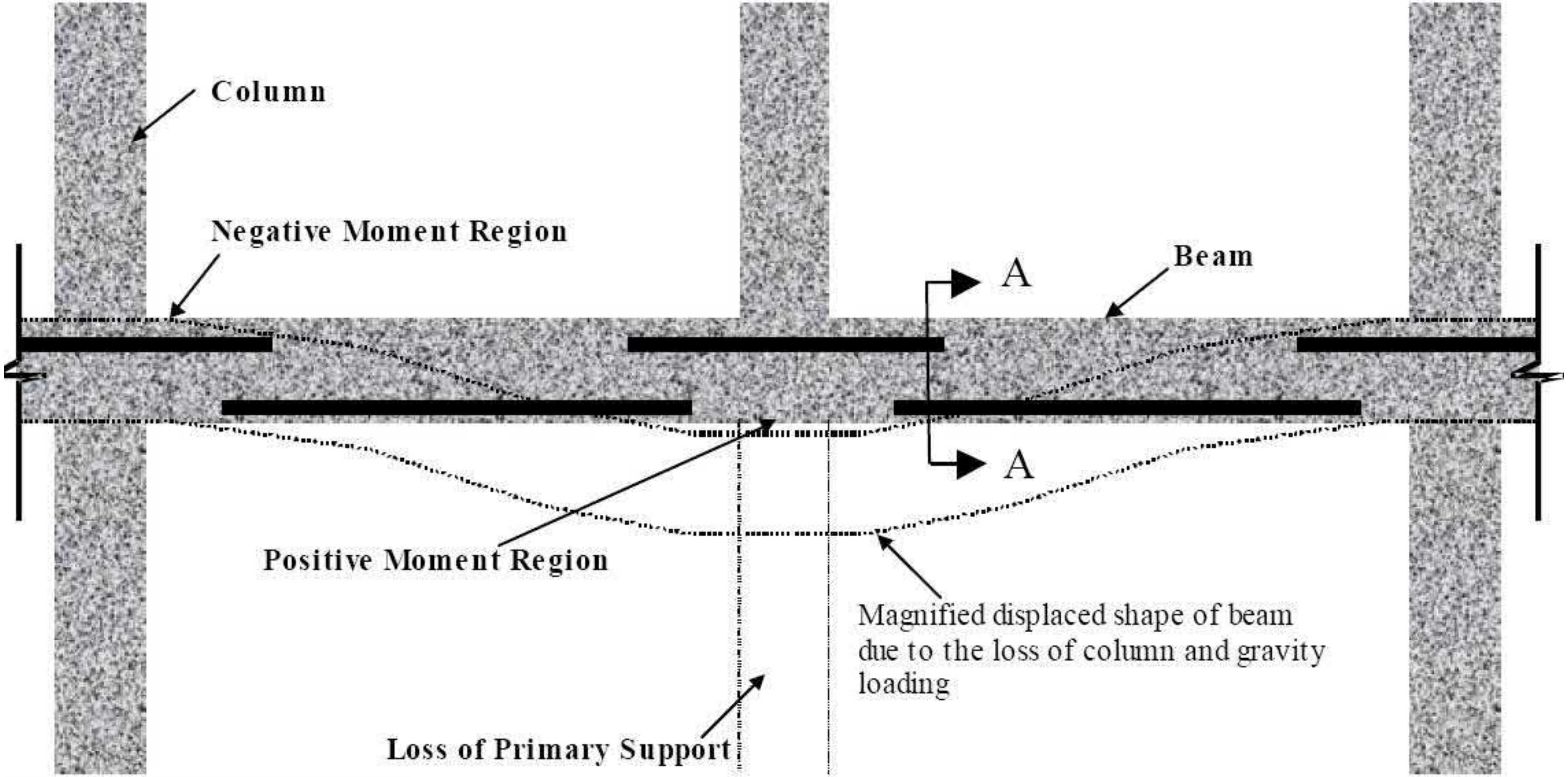
Direct Design Methodu – Duvar ve Kolon Göçmesinin Varsayılması

- Assume sudden loss of any load bearing component around perimeter or non-secure interior area of building
- Check increased loads throughout structure and foundation due to load redistribution
  - Increased flexure, shear, connection loads including localized connection stresses
- Check maximum dynamic deflections if dynamic analysis
- Check overall stability of remaining structure with increased axial loads
- Review detailing to improve ductility, resist stress reversals and loads opposite gravity

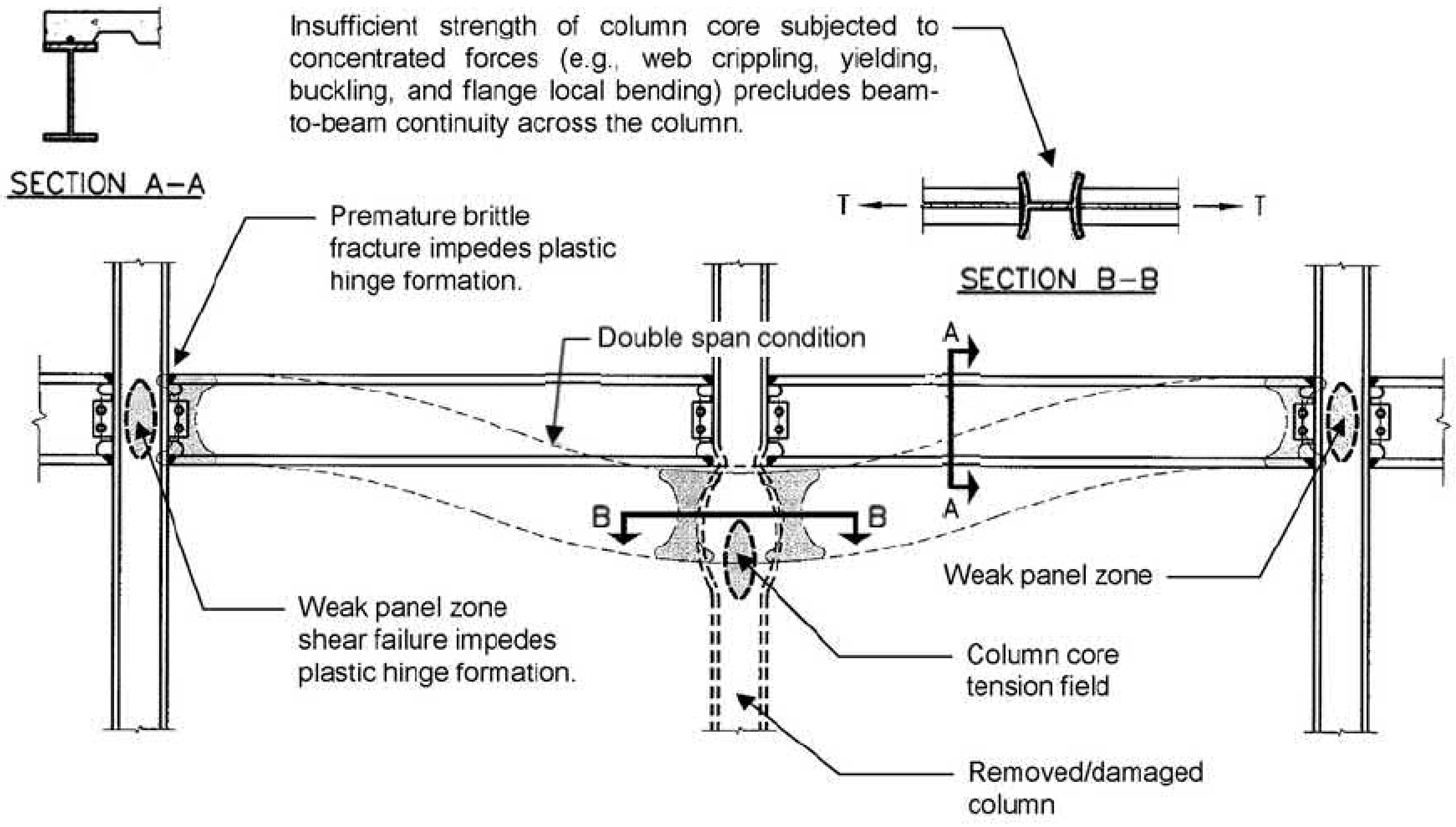
Tasarım Stratejileri –Alternatif Yük Yolu

- Increase moment capacity in beams or slabs to span over failed components
- Detail components and connections to allow catenary action over failed components
- Design for truss action of multi-story frame over failed column
  - Vierendeel truss
- Provide shorter spans near building corners so perimeter beams can cantilever over failed corner columns
- Provide multiple shear walls
- Avoid construction types that limit frame continuity
  - Precast concrete frames, steel frames with shear tab connections

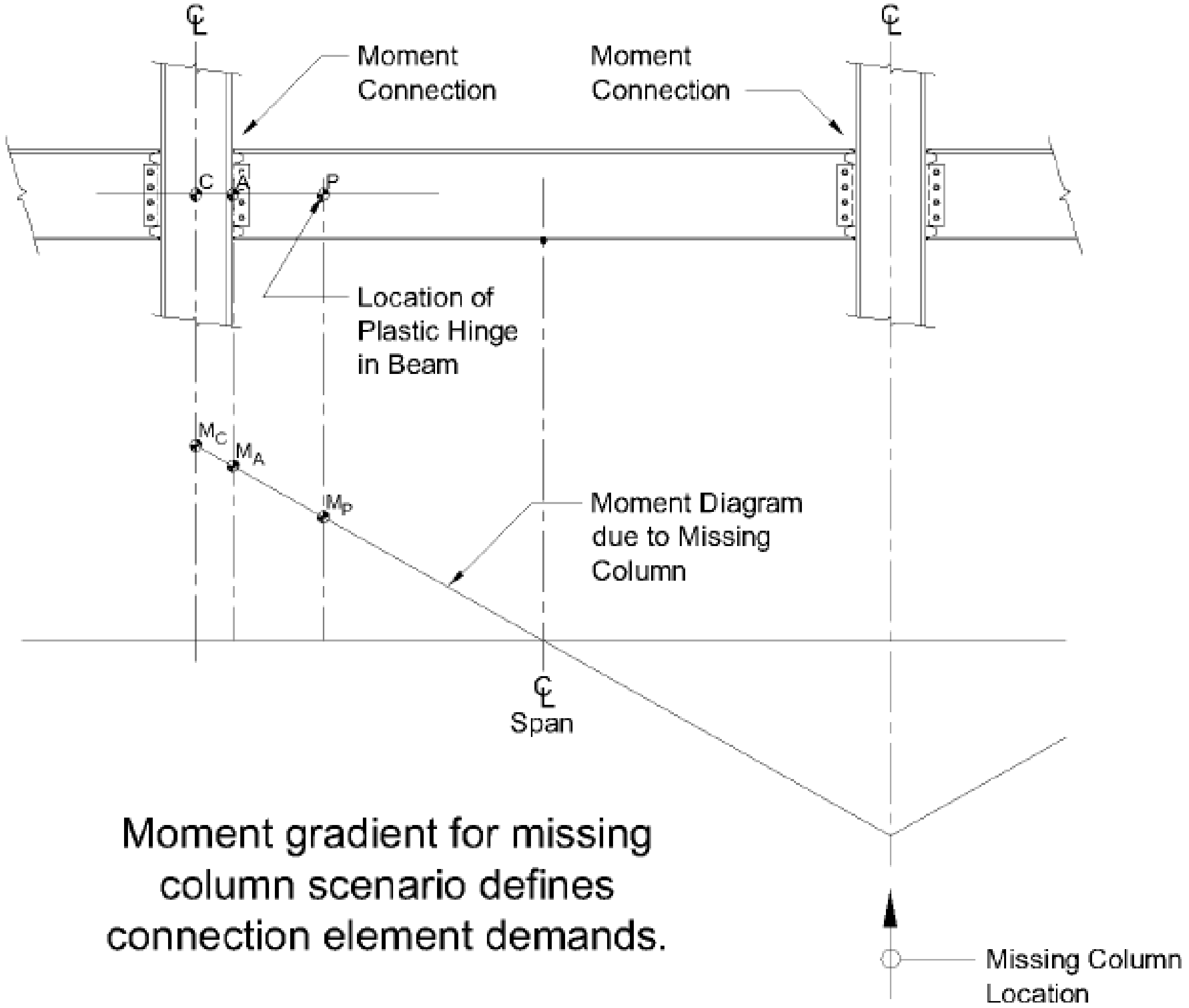
Betonarme Kirişlerin Maksimum Moment Bölgelerindeki Değişim



Kolon Kaybından Kaynaklanan Çelik Çerçeve Bağlantılarındaki Artan Lokal Gerilmeler



Bağlantı Alanında Eğilme Akması Sonucu Artan Gerilmeler



Moment gradient for missing column scenario defines connection element demands.

Belirtilen Tasarım Yükleri ile Indirect Method Tasarımı (DoD Yaklaşımı)

Horizontal ties

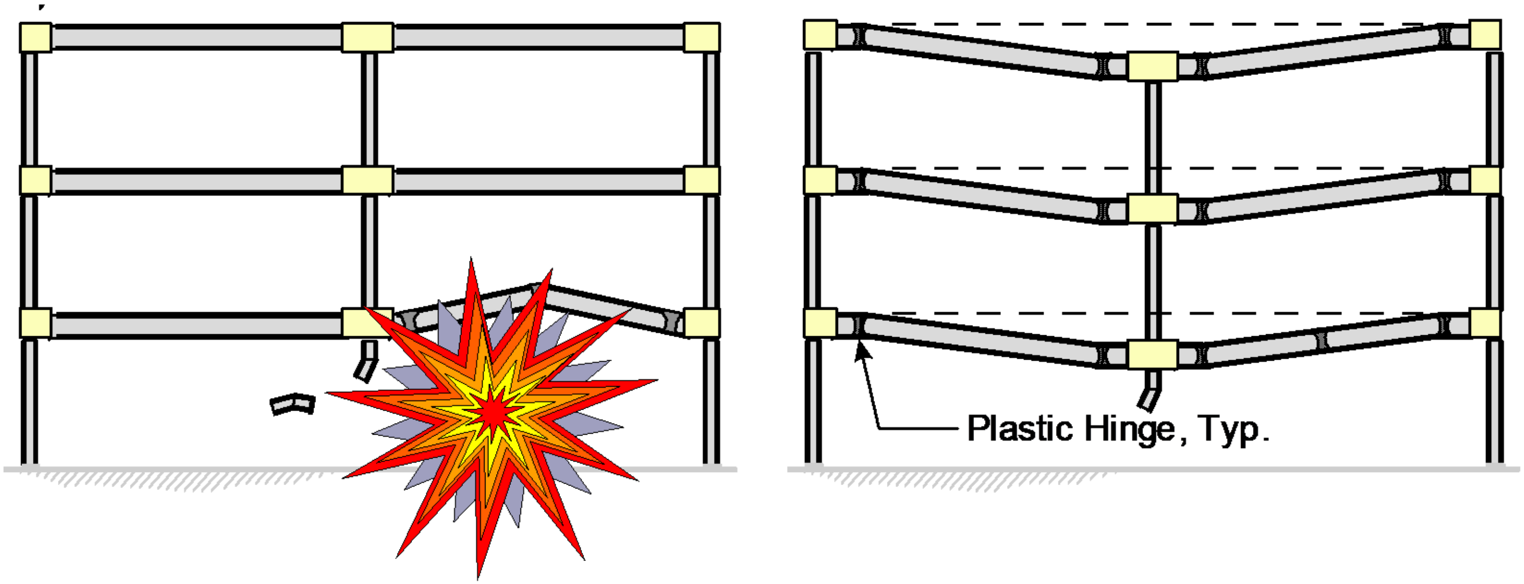
- Internal ties at each floor level – continuous in both directions
- Peripheral ties at each floor level – wrap the structure
- Peripheral ties extend into perimeter columns

Vertical ties

- Continuous axial tension tie in load bearing elements

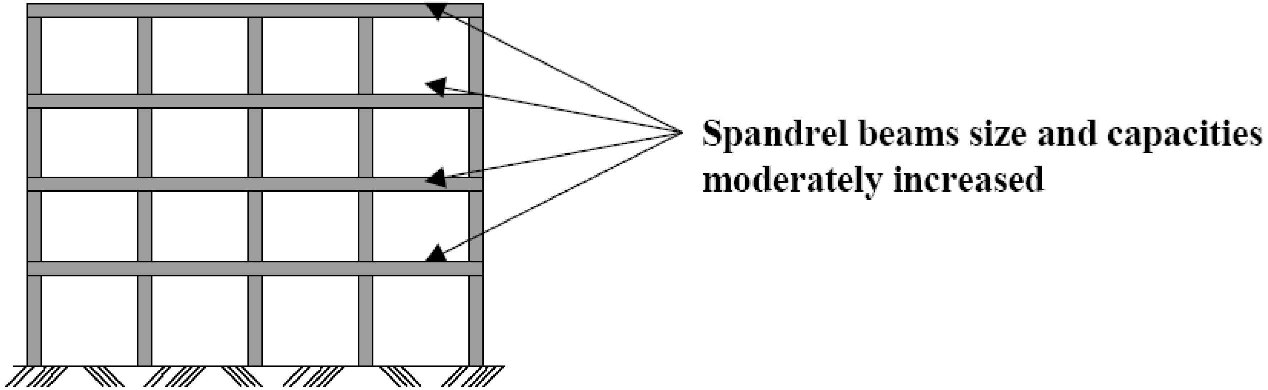
Specified ties forces based on static design loads

Katenar Davranışı – Göçen Kolon üzerindeki Çevresel Kiriş

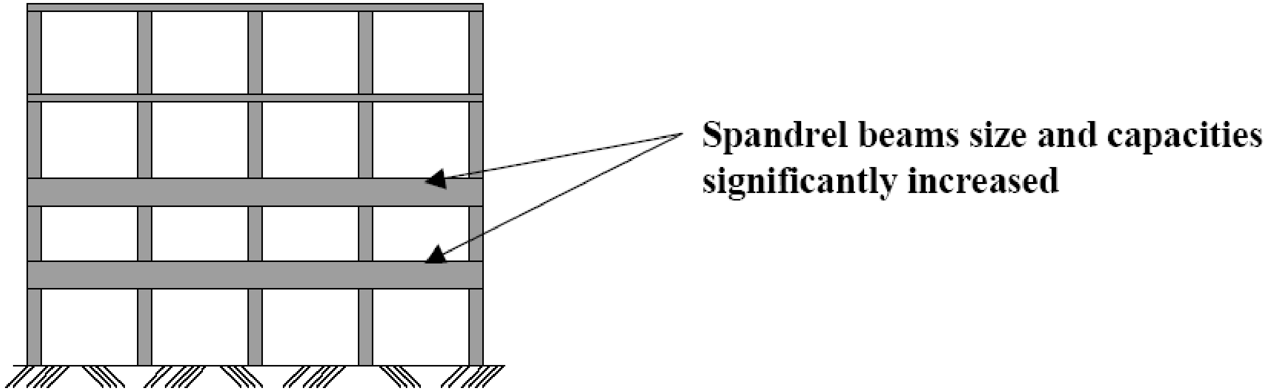


Note enhanced beam-column connections in steel framing

Göçen Kolon Üzerinde Yukarıdan Gelen Yükleri Taşımak İçin Güçlendirilmiş Çevre Kirişleri

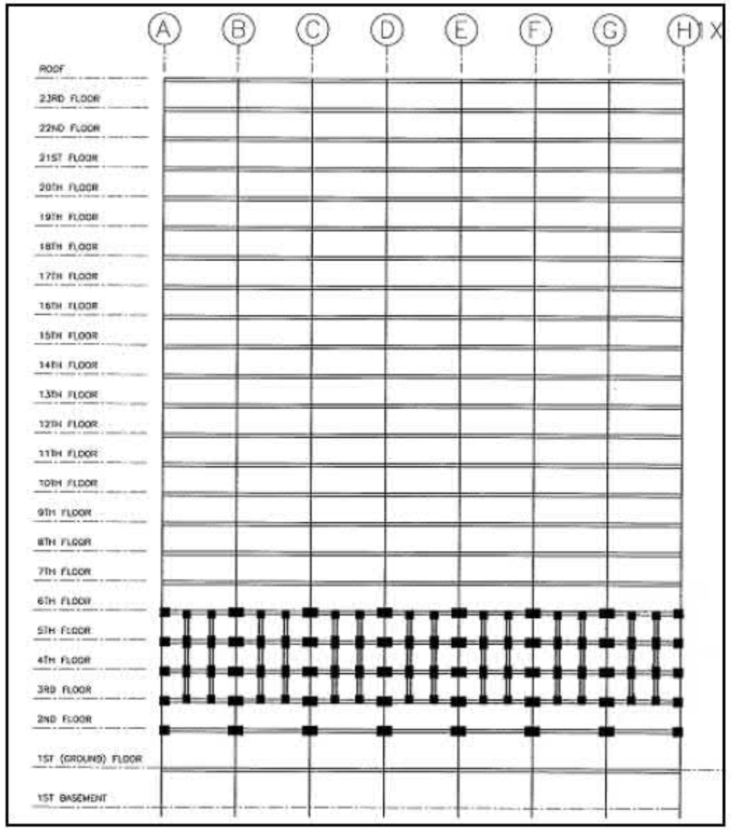


Redesign
(improvements distributed evenly over the entire height)

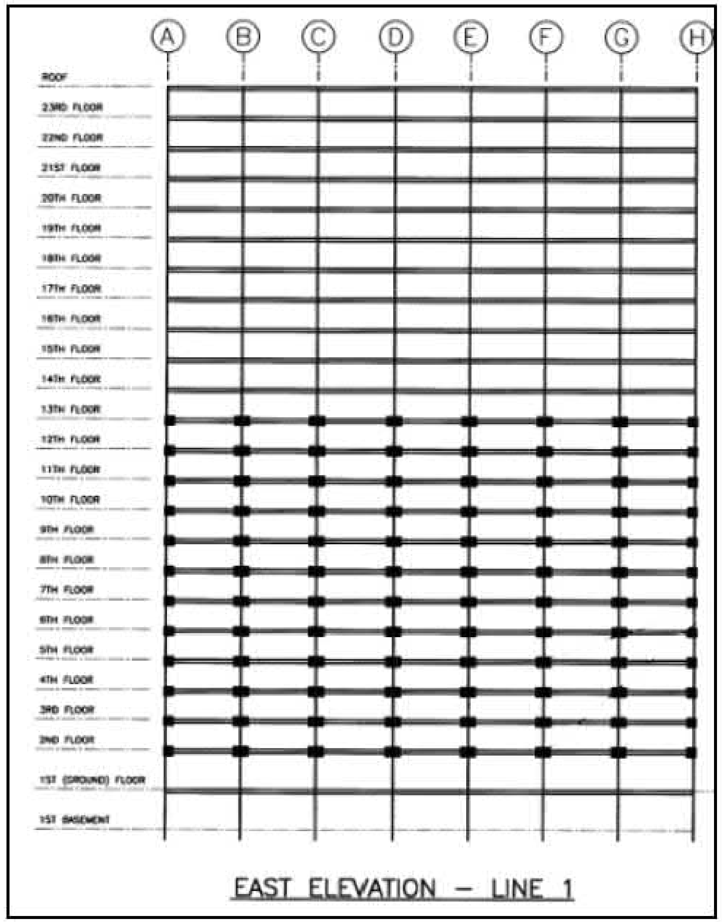


Redesign
(improvements concentrated on the 2nd and 3rd floor level)

Çelik Çerçeve Yapının Alt Katlarındaki Güçlendirilmiş Çevre Kirişleri



Lower floor perimeter beams designed as Vierendeel truss



Lower floor perimeter beams designed with ductile moment connections

Teşekkür ederim!

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