

Aluminum Foam

Blast Mitigation System



2019



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Aluminum Foam Applications for Defense Industry

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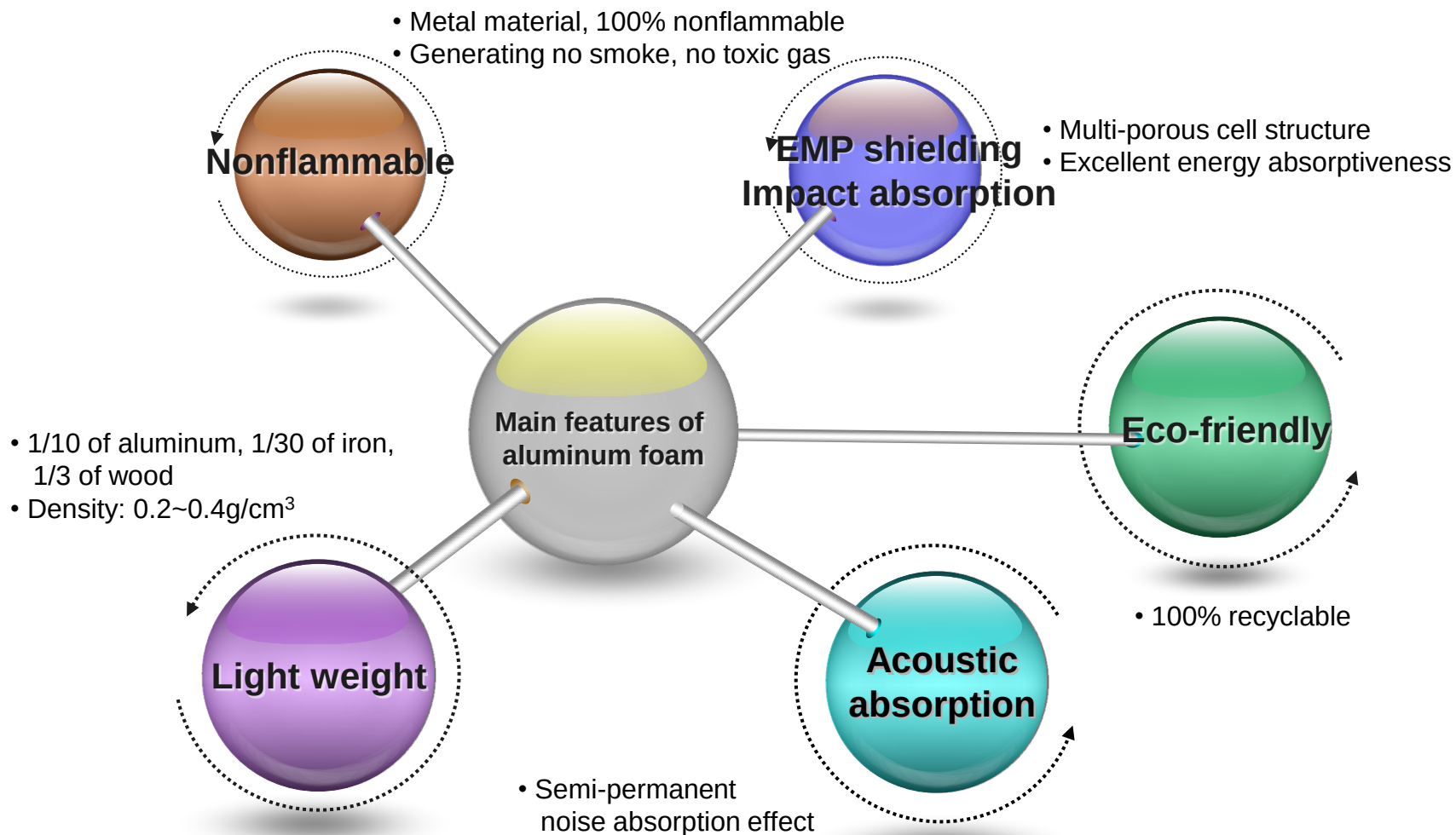
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1. Introduction

1-1. Features of aluminum foam



1. Introduction

1-2. Application



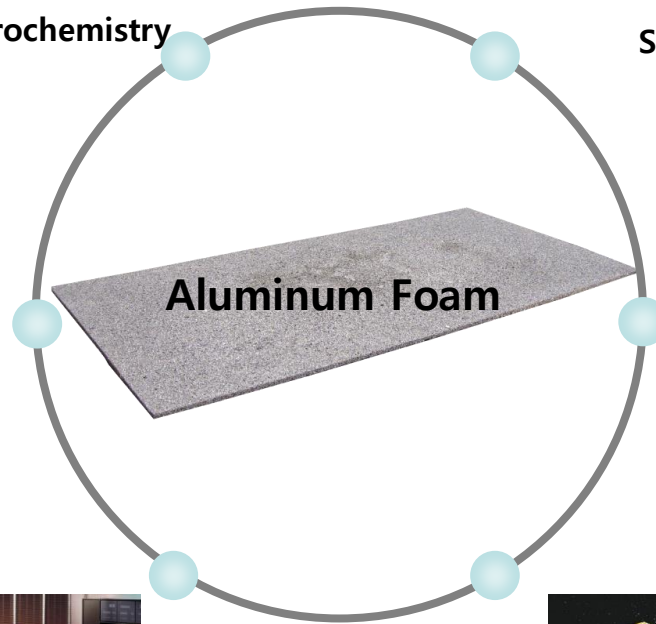
Steel Industry/Plant/Petrochemistry



Shipbuilding/Vehicle/Railroad



**Architecture
Civil Engineering**



**National Defense
Military Supplies**



Furniture (Household, Other)



Application Industry Section

1. Introduction

1-3. What is aluminum foam?

■ Aluminum foam is the ultra-light metal that is formed by the mixture of melted aluminum ingot, increasing viscosity factor and foaming agent.

■ Special features of Aluminum Foam

- Ultra-light
 - Density is $0.2 \sim 0.4\text{g/cm}^3$ (Aluminum1/10, Iron1/30, Wood1/4)
- Acoustic absorption
 - Porous foam and semi-permanent acoustic absorbent
- Non-flammability
 - 100% non-flammability and no toxic gas
 - Certified materials passed Non-Combustibility TEST
 - Certified materials passed Non-flammability TEST
- Energy absorptiveness
 - Porous foam is the effective energy absorbent
 - acquired the first SB5 class in Korea (Guard rail shock-Absorber)
- Electromagnetic wave Shielding ability
 - Can be maintained high penetration loss >93dB by thin thickness
 - Suitable to as broadcasting station, hospital and etc for electromagnetic shielding materials with sound absorption ability
- Eco-friendly
 - Nonpoisonous, odorless and harmless materials
 - 100% recyclable

■ Performance of Aluminum Foam

Basic feature	Chemical composition	over 97% of aluminum
	Cell type	Closed-cell
	Density	0.2 ~ 0.4
Acoustic Feature	Acoustic absorption Coefficient	NRC 0.70
Mechanical Feature	Tensile strength	1.3 ~ 2.0 MPa
	Compressive strength	1.5 ~ 2.0 MPa
Thermic Feature	Thermal conductivity	0.268 W/m. K
	Melting point	Over 730°C
Extra Feature	Electromagnetic waves shielding ability	over 93 dB
	Salt spray test	No Corrosion

2. Blast Mitigation System

2-1. Concept of blast mitigation system

TYPE 1.
Building (barrack)



TYPE2.
Building
(container barrack)

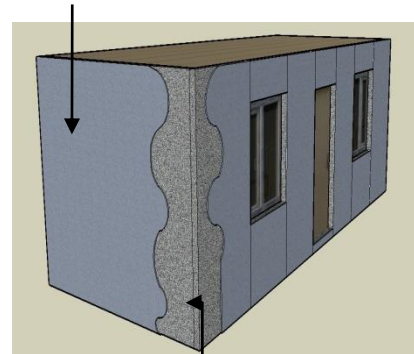


TYPE3.
Outer protective wall
(T type concrete)



Protective wall concept with aluminum foam

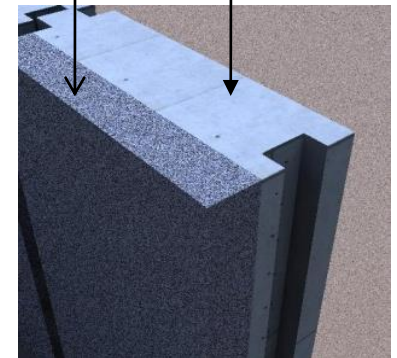
Steel plate



Aluminum foam

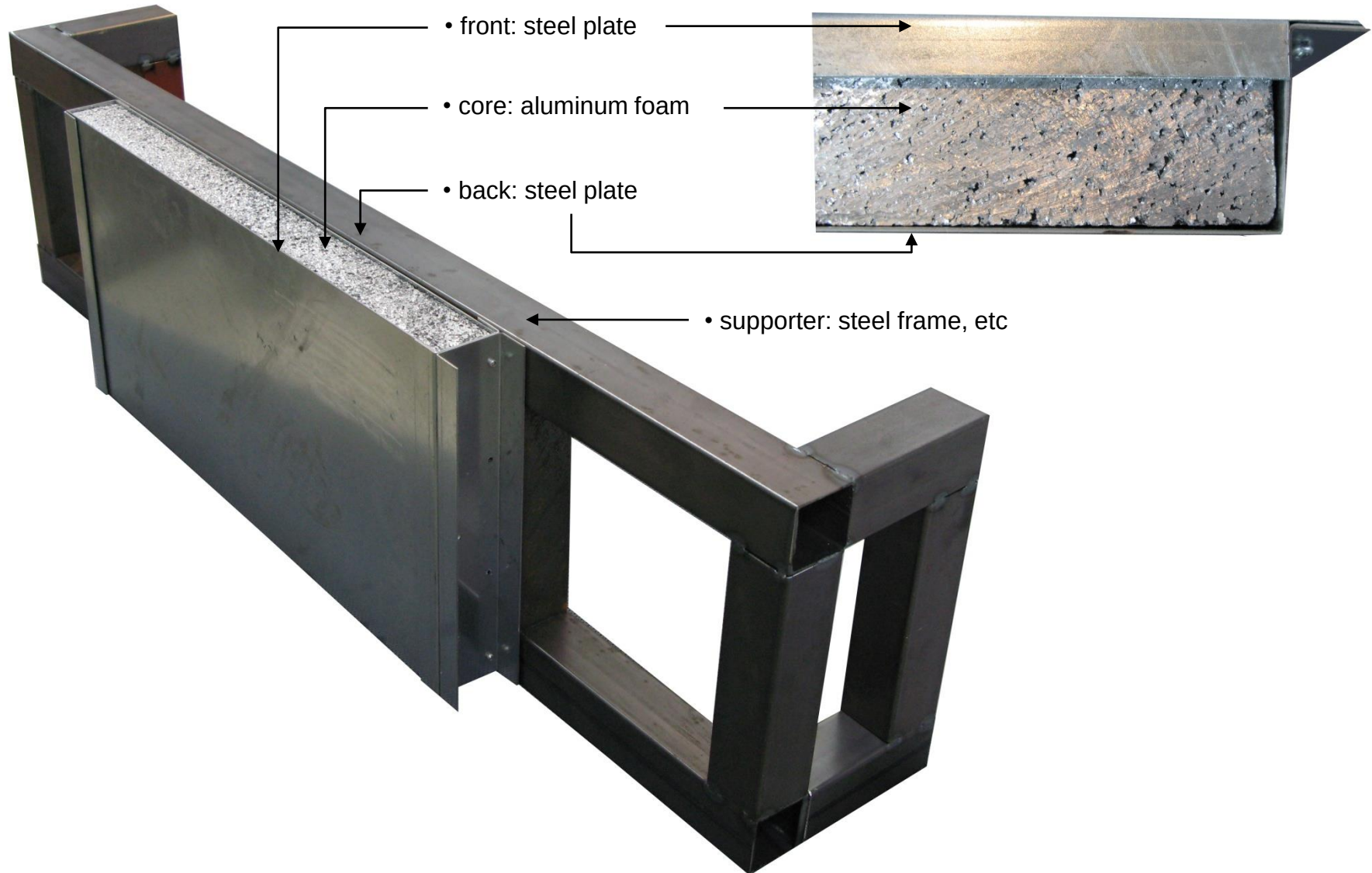
With aluminum foam, impact absorption ability of building and concrete outer walls are increasing and preventing direct damage by bomb and secondary damage by splinters of a shell.

Concrete



2. Blast Mitigation System

2-2. Specification



3. Efficiency Test of Blast Mitigation System

3-1. Test information

Test date		(1) Date: May 24, 2010 3:30 pm
Test explanation	Test 1	(1) Efficiency test of aluminum foam panel (total 27 types) (2) Explosion scale: C4 / 7.60kg (3) Separation distance: 0.9, 2.0, 3.0, 4.0, 5.0m
	Test 2	(1) Roof panel(general polystyrene foam sandwich panel), sand bag 250mm, aluminum foam shielding wall 50mm, steel panel 5.0mm (2) Explosion scale: C4 / 1.13kg (3) Separation distance: 15cm (severe condition test)

3. Efficiency Test of Blast Mitigation System

3-2. Arrangement for the test 1 <installation of 27 types aluminum foam blast mitigation system>



3. Efficiency Test of Blast Mitigation System

3-3. Installation of explosive for test 1(C4/7.60kg)



3. Efficiency Test of Blast Mitigation System

3-4. The result of test 1-1

Before the test



After the test



- (1) Test images under the severe condition (C4/7.6kg, separation distance 0.9m)
- (2) Damaged but no penetration through the test panels
- (3) An explosive expert group evaluate the panels have excellent efficiency of blast mitigation regarding the explosive test condition.

3. Blast Mitigation System Efficiency Test

3-5. Arrangement for the test 1-2



3. Blast Mitigation System Efficiency Test

3-5. The result of test 1-2

Sandwich panel (50mm)



Demolished completely

Concrete panel (50mm)



Cracked horizontally

Aluminum foam (50mm)



No damage but bended slightly (6mm)

3. Efficiency Test of Blast Mitigation System

3-6. Arrangement for test 2



3. Efficiency Test of Blast Mitigation System

3-7. The result of test 2



Polystyrene sandwich panel destroyed completely

Sand bag damaged partially

Aluminum foam panel sustained with little deformation

3. Efficiency Test of Blast Mitigation System

3-8. Summary of test result

Test 1;

- (1) No penetration through the aluminum foam panel**
- (2) Bending degree of aluminum foam after explosion: 6.0mm**
- (3) Roof material(general sandwich panel) : destroyed and vanished completely**

Test 2;

- (1) Polystyrene sandwich panel destroyed completely**
 - Sand bag damaged partially**
 - Aluminum foam panel sustained with little deformation (bending degree 10mm)**
- (2) Internal pressure figure: 0.6psi**
(Refer to next page for more detail on blast effect)

3. Efficiency Test of Blast Mitigation System

3-8. Summary of test result

Table 1-1 Blast Effects In Man Applicable To Fast-Rising Air Blasts Of Short Duration (3-5 ms)

Critical Organ or Event	Maximum Effective Pressure (psi)*
Eardrum Rupture	
Threshold	5
50 percent	15
Lung Damage	
Threshold	30-40
50 percent	80 and above
Lethality	
Threshold	100-120
50 percent	130-180
Near 100 percent	200-250