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Successful blasting with Smart-stem, an innovative and amazing stemming

Smartstem Bench Blasting
Smartstem Tunnel Blasting

SEOKSEONG
Blasting Construction Co., Ltd.

KICT
KOREA INSTITUTE of CIVIL ENGINEERING and BUILDING TECHNOLOGY
2021~2023 Family Company

World's first blasting method for smart materials

Smart-Stem® Development Motivation

Until now, the blasting industry has focused on the development of explosives and detonators, which have greatly improved safety against accidental explosions and user convenience, but have not solved various secondary problems that occur immediately after blasting, such as blow-out, poor crushing and flying rock. We noted that the secondary breaking work became the most troublesome factor among the various influencing factors related to blasting, so we developed the Smart- Stem® in collaboration with the KICT(Korea Institute of Civil Engineering and Building Technology).

Blasting results vary greatly depending on who charges stemming materials, which means there is a high probability of incorrect charging. The charging materials hold strongly resist the explosion of the gunpowder in order to increase the explosive energy efficiency and the duration (effective) time in the hole. However, on-site blasters become impatient to finish the charging in time, which leads to incorrect charging. In order to solve above mentioned problems we invented a new stemming materials suitable for this situation.

Smart-Stem® is easy to use, and can completely prevent the loss of explosive energy in the hole. We decided to call it Smart-Stem®, an innovative product for the 21st century. Smart-Stem® is not just a common stems. It was developed for sites that do not want to fail blasting with a common stems. Our Smart-Stem® is a good news to the sites that want to save blasting costs and secondary rock breaking costs, and to be free from complaints by suppressing overdetonation.

Smart-stem®

Common stemming material

Blow-out Occurrence

Currently, blasting materials are compacted sand, drilled rock powder, aggregate, etc., which have a large compression ratio due to the large number of voids and low friction with the void wall, resulting in air emission (airborne fugitive).

Explosive energy dissipates quickly

Blast energy dissipates quickly in the direction of the hole, resulting in increased noise, flying rock, and reduced crushing and digging efficiency.

Increased air, construction costs

Due to the large amount of big stones, it is difficult to secure economic efficiency. Due to the increased cost of blasting, transportation and loading, and secondary rock breaking.

Patent
No. 10-2418199

Patent Name
Shock wave responsive shear thickening, fluid stemming and blasting method using the same

Patent Registration Date
June 03, 2020

Technology Overview
The Smart-Stem blasting method is a new blasting method that sustains explosive energy in the blasting hole for a long time (increasing the chemical reaction of explosives) when a strong shock wave is transmitted to the shear thickening fluid in the form of an elastic wave, thereby increasing crushing efficiency and excavation rate, reducing vibration noise, and reducing rock flying.

Smart-stem

Blow-out Anti-effect

The Smart-Stem works with a mixed stemming method, where the Smart-Stem® is inserted first and the remaining space is filled with general stemming material, and prevents Blow-out to improve blast energy efficiency.

Maximizing blast energy efficiency

Smart-Stem maximizes the effectiveness of blasting by mixing shear thickening fluid as a stemming agent to prevent blow-out and scattering, and increase blasting efficiency such as blasting crushing degree and excavation rate.

Increased economic efficiency such as air and construction cost reduction

The ideal stemming effect of Smart-Stem is to induces complete destruction, which is very advantageous for air shortening and securing economy.

World's first blasting method for smart materials

Features of Smart-stem

Features of Common stemming material

Drilling cuttings

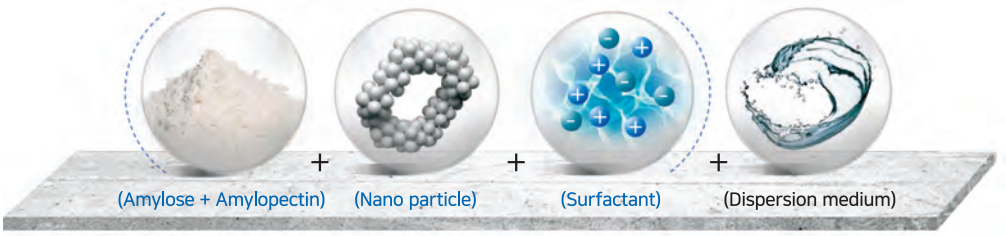
Sand

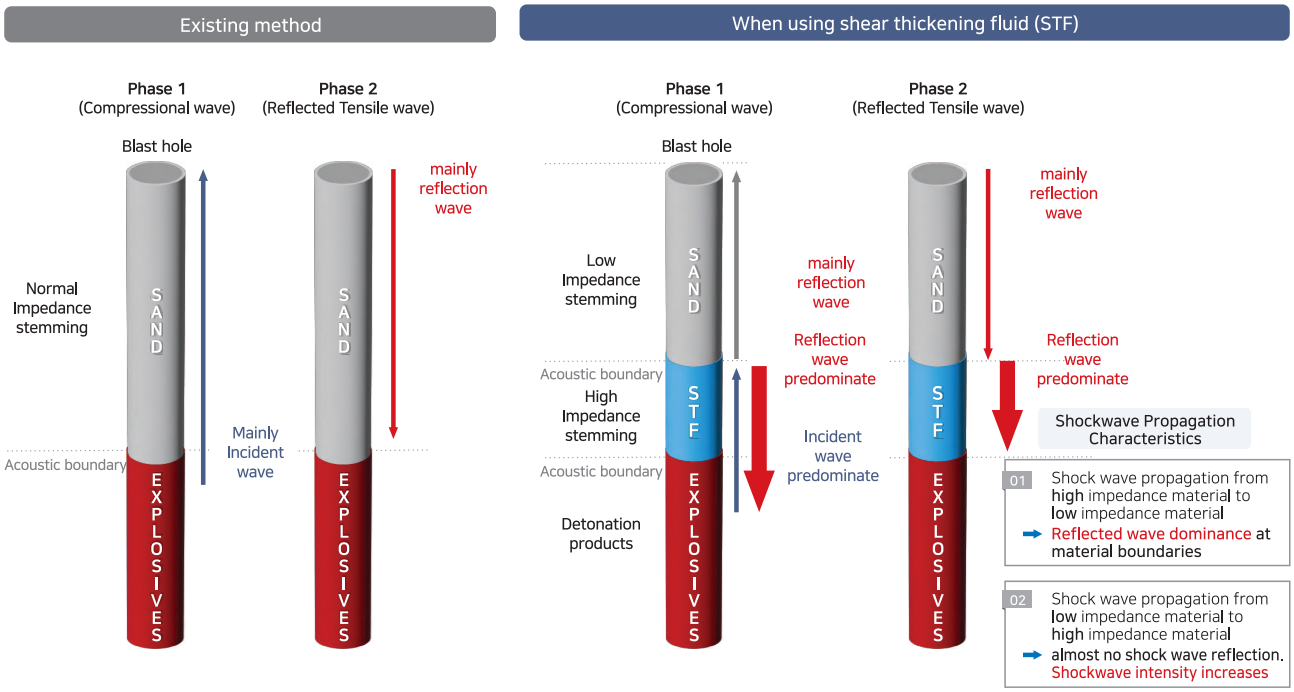
Crushed stone aggregate not exceeding 13mm

- Common stemming materials typically consist of sand, stone aggregate, and rock particles, which have a high compression deformation ratio due to their porosity(air-gaps) and limited frictional effect with the blast hole wall. While solid materials like mortar and gypsum can enhance stemming effectiveness, their application involves complex work processes that significantly increase material and labor costs.
- Fluids such as water are non-compressible materials and exhibit rigid body motion at the initial time of explosion, but have no friction effect with the blast hole wall, and may be lost to rock mass discontinuities reducing the effect of stemming.

Features of Smart-stem

Smart-Stem is an environmentally friendly fluid composed of organic and inorganic materials, including a base, strength enhancer, binder, and dispersant. It contains a shear-thickening fluid that exhibits a rapid increase in viscosity as external force intensifies, transitioning from a fluid to a solid state above the critical shear rate. This innovative material is harmless to the human body and readily biodegrades within a few months under natural conditions, eliminating concerns about soil and water pollution.



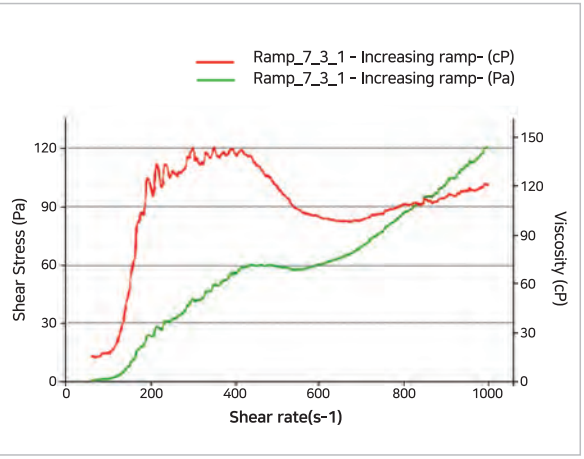


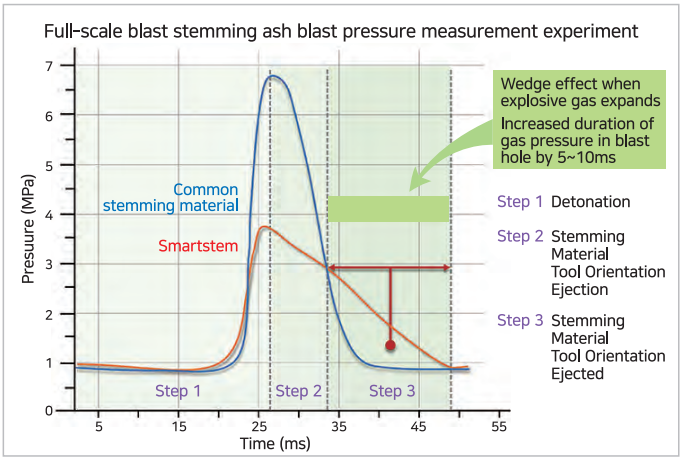
Smart-stem®

Substance	Density (kg/㎥)	Sonic velocity (m/s)	Acoustic Impedance (kg/(㎡s))
Air	1.0	330	330
Sand, Gravel	1,800	750	1.35×106
Water	1,000	1,480	1.48×106
Viscous fluid	1,260	1,908	2.50×106
Shear Enrichment Fluid	1,600	1,600	3.28×106

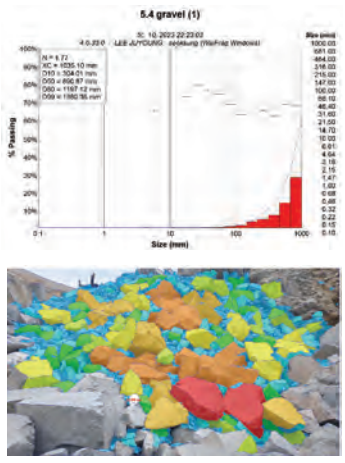
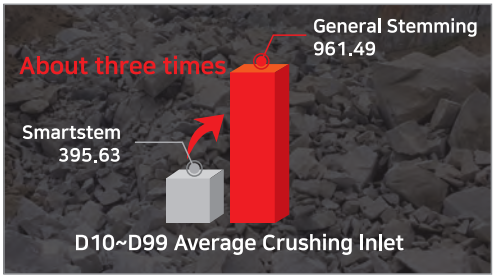
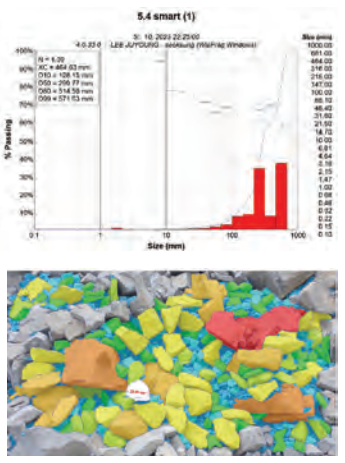
* ASTM(American Society for Testing and Materials)

Smart-stem Mechanism





- Explosive Detonation : Shockwave
- Delivering shockwaves to smart systems (solidification + shear deformation to increase void friction)
- Increased high-speed shear resistance by 10 times
- Wedge effect when explosive gas expands
- Increased duration of gas pressure in blast hole by 5~10ms

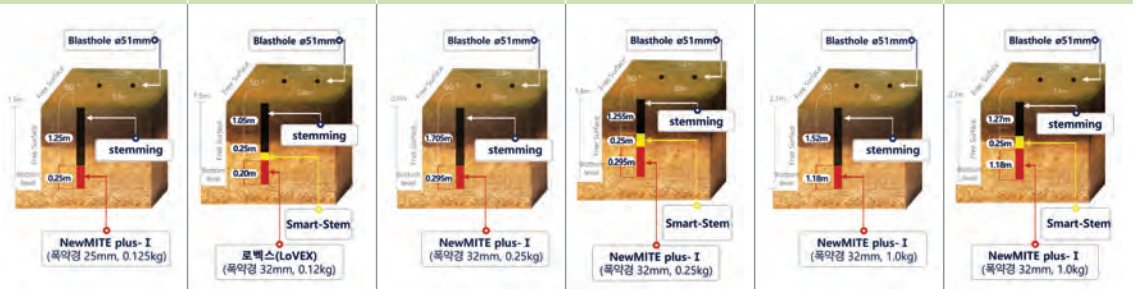
Common stemming material	Fracture improvement rate	Smartstem
		

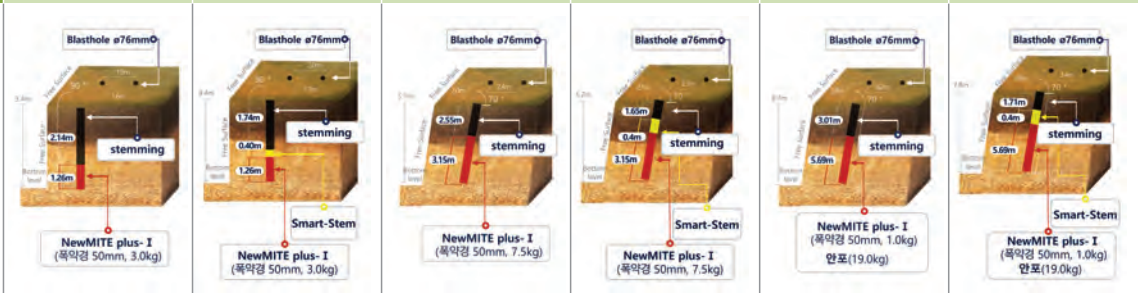
D10 ~ D99 Smartstem blasting average crush improved by 1/3 compared to the common stemming.

World's first blasting method for smart materials

Application of Smart-Stem, a new construction method

Smart-Stem Bench Blasting

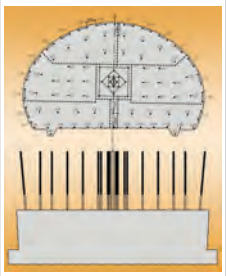
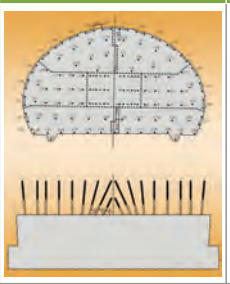
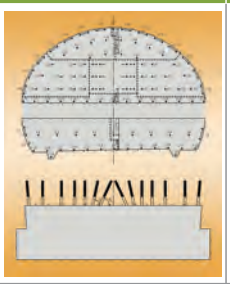
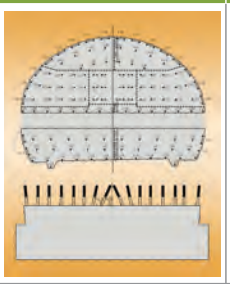
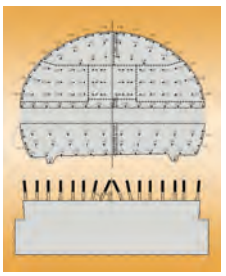
Classification	TYPE-1 Micro-Vibratory Excavation Methods		TYPE-2 Precision Vibration Controlled Blasting		TYPE-3 Small-scale vibration Controlled Blasting	
	Existing method	Smartstem	Existing method	Smartstem	Existing method	Smartstem
Patterns						
Perforation Venue	1.5m	1.5m	2.0m	1.8m	2.7m	2.7m
Minimum Resistance	0.7m	0.8m	0.7m	0.8m	1.0m	1.1m
Spacing	0.7m	0.8m	0.8m	1.0m	1.2m	1.3m
Charge weights	0.125kg	0.120kg	0.250kg	0.250kg	1.000kg	1.000kg
Excavation Volume	0.637㎥	0.832㎥	1.01㎥	1.28㎥	2.88㎥	3.432㎥
Stemming Length	-	0.25m	-	0.25m	-	0.25m

Classification	TYPE-4 Middel-scale vibration Controlled Blasting		TYPE-5 General Blasting		TYPE-6 Great Blasting	
	Existing method	Smartstem	Existing method	Smartstem	Existing method	Smartstem
Patterns						
Perforation Venue	3.4m	3.4m	5.7m	5.2m	8.7m	7.8m
Minimum Resistance	1.6m	1.7m	2.0m	2.1m	2.8m	2.8m
Perforation Gap	1.9m	2.0m	2.5m	2.5m	3.2m	3.4m
Charge weights	3.0kg	3.0kg	7.5kg	7.5kg	20.0kg	20.0kg
Excavation Volume	9.12㎥	9.86㎥	24.0㎥	24.15㎥	65.40㎥	66.64㎥
Stemming Length	-	0.4m	-	0.4m	-	0.4m

* Depending on the rock strength and site conditions, the drilling length, resistance line, and space gap can be added or subtracted

Smart-stem®

Smart-Stem Tunnel Blasting

Support pattern	P-1,2	P-3	P-4	P-5	P-6
Patterns					
Excavation Length(m)	3.500	2.000	1.500	1.200	1.000
Charge weights(kg)	2.400	1.000	0.625	0.500	0.375
Specific charge(kg/㎥)	0.882	0.810	0.762	0.725	0.695
Burden(m)	1.000	0.900	0.850	0.800	0.750
Spacing(m)	1.100	0.950	0.900	0.850	0.800
Charge Length(m)	2.520	1.180	0.738	0.590	0.443
Stemmning Length(m)	1.280	1.020	0.963	0.710	0.658
Drilling Length(m)	3.800	2.200	1.700	1.300	1.100

* Depending on the rock strength and site conditions, the drilling length, resistance line, and space gap can be added or subtracted

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Construction Order of Smart-Stem Bench Blasting

Drilling → Charging → Smartstem → General Stemming → Connectting → Blasting → Muckfile → Supporting

Hybrid Stemming

01

Drilling according to the blasting source

- Same as existing method

02

Inspection of perforations

- Same as existing method

03

Charging

- Load explosives and detonators into the drilled hole
- Same as existing method

04

Insert the Smart-Stem

- Inserting the smart system into the lower part of the drilled hole.

05

Hybrid stemming

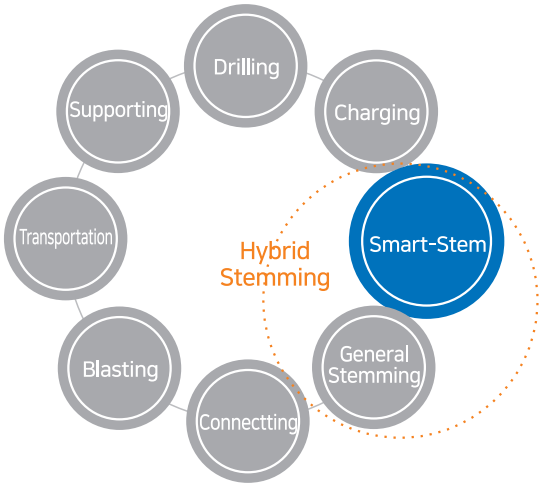
- Insert conventional stemming material in the remaining upper part
- Same as existing method

06

Blasting

- Conducting perimeter control and checking water
- Same as existing method

Construction Order of Smart-Stem Tunnel Blasting



01

Drilling according to the blasting source

- Same as existing method

02

Shrinkage of perforations

- Same as existing method

03

Charging

- Loading explosives and detonators into the drilled hole
- Same as existing method

04

Insert the Smart-Stem

- Inserting the Smart-Stem (Shear Thickening Fluid) into the lower part of the drilled hole.

05

General Searching

- Insert conventional coloring material in the remaining upper part
- Same as existing method

06

Blasting

- Conducting perimeter control and checking water
- Same as existing method

World's first blasting method for smart materials

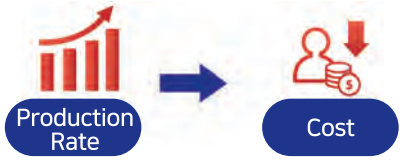
Successful blasting with Smartstem, an innovative and surprising pre-colorant

Innovation of technology

- **The world's first smart blasting stemming material**
  World's first smart material application blasting utilizing Shear Thickening Fluid
- **Economical and eco-friendly blasting method**
  Reduces construction costs by about 20% compared to conventional blasting, and reduces blasting vibrations in urban areas by up to 50% or more.
- **Reduces large portion of labor costs through mass production**
  Possible large-scale field application and market expansion of Smart-Stem system products
- **Infrastructure Performance**

National Academy of Sciences "Eureka Alert" and media coverage in France, Brazil, China, and more

Reduce costs through mass production



Enable large-scale field application and market expansion of Smart-Stem®.

- egistered with Korea Expressway Corporation Technology Market (March 2023)
- Reflected the design of Yeoju Wonju Double Line Railway Roadbed Construction Project 1 (Implementation)
- Reflected the design of GTX-B (implementation) (scheduled to be constructed in the second half of 23)
- Conducted explosion-proof (pellet) test of structures at the Jangseong Explosion Test Site of the Korea Army Institute of Technology Demonstration of future power (June 23)
- Participated in the 2023 Road Day Technology Exhibition hosted by the Ministry of Land, Infrastructure, and Transport, Korea Expressway Corporation, and Korea Road Association (July 2023)

[Department of Defense Future Power]

Event Obstacle Collapse Test

Explosion Protection (Bullet) Performance Testing

Smart-stem®

Smartstem certification

Patent certificate

Patent certificate

Patent certificate

Patent certificate

Trademark registration certificate

ISO 9001

ISO 14001

KICT Family company

KOITA membership

SOC's Smartstem blasting method

Venture business confirmation

KITA membership

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KOREA INSTITUTE of CONSTRUCTION TECHNOLOGY

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SMART STEMMING

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SEOKSEONG
Blasting Construction Co., Ltd.

3rd floor,118, Gyeomjae-ro, Jungnang-gu, Seoul, Republic of Korea

T. +82-2-522-5681 F. +82-2-522-5683

E-mail. jyj5681@naver.com

M. +82-10-6226-5681

URL www.seokseong.co.kr