Seven®
REFRACTORIES

TECHNOLOGY
AHEAD

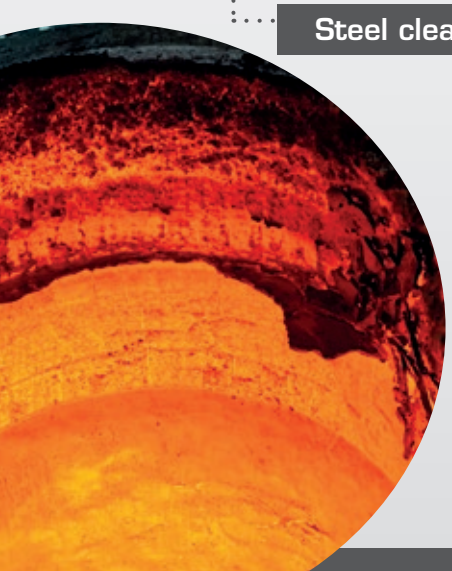
STEEL INDUSTRY

STEEL LADLE

Seven's aim in ladle lining:

- Develop advanced monolithic products and services
- Supply solutions according to customer requirements
- Achieve top performance levels
- Ensure cost effective results

Steel cleanliness is safeguarded by high alumina-spinel products



Fully integrated monolithic solutions have been engineered for any steel ladle lining with:

- Low and ultra-low cement castable
- Precasted pieces ready for use
- Ramming, gunning and shotcrete mixes

produced with selected and high grade raw materials.

1
CLOSING RIM
RAMMING MIX OR PATCHING CASTABLE

2
SLAG WORKING LINING
MgO-C BRICKS, SHOTCRETING CASTABLE
(REPAIR ONLY)

3
WORKING LINING
VIBRATING CASTABLE, SELF FLOWING
CASTABLE, SHOTCRETING CASTABLE
(REPAIR ONLY)

4
SIDEWALL SAFETY LINING
REINFORCED-VIBRATING CASTABLE
OR SELF-FLOWING CASTABLE

5
PERMANENT SAFETY LINING
ALUMINA BRICKS OR SELF-FLOWING CASTABLE

6
SHELL PROTECTION
HIGH INSULATING MATERIAL

7
BOTTOM FILLING LINING
VIBRATING CASTABLE, SELF-FLOWING
CASTABLE OR PRECASTED BLOCKS

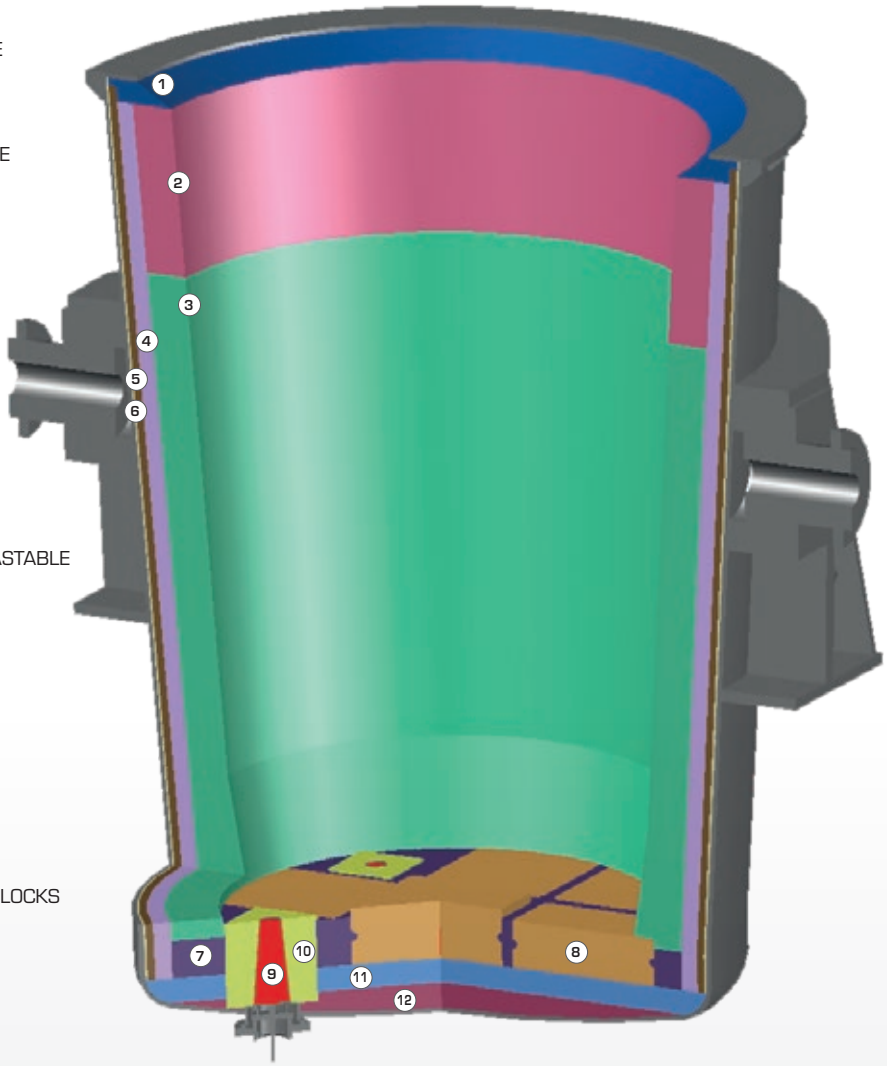
8
BOTTOM WORKING LINING
VIBRATING CASTABLE OR PRECASTED BLOCKS

9
PURGING PLUG
PRECASTED HIGH ALUMINA SET

10
WELL BLOCK
PRECASTED HIGH ALUMINA SET

11
BOTTOM SAFETY LINING
VIBRATING OR SELF-FLOWING CASTABLE

12
LEVELING UNDER BOTTOM
VIBRATING OR SELF-FLOWING CASTABLE



Seven Refractories contributes to minimizing costs by lowering the specific consumption and by extending the service life of the ladles.

All products manufactured by Seven Refractories are designed in compliance with EC legislation in terms of health and safety, as well as emission and wastage impact.

THE PRODUCTS

Alumina-spinel monolithic refractories are used in the steel ladle since the beginning of '90's, but only nowadays the utilization of those materials is becoming more and more extended". These concepts give an answer to the different pattern of wear due to their individual peculiarity in terms of chemical and physical properties.

Seven Refractories formulated several optimized products for the different steel ladle zones depending of the dominant wear mechanism:

- **vibrating castables**
- **self-flowing castables**
- **shotcrete castables**

Our solutions are based on high alumina spinel containing or spinel forming castables.

Spinel containing or spinel forming castables have quite different final properties and their use is related to the application where mainly high mechanical strength or highly elastic behaviour is demanded.

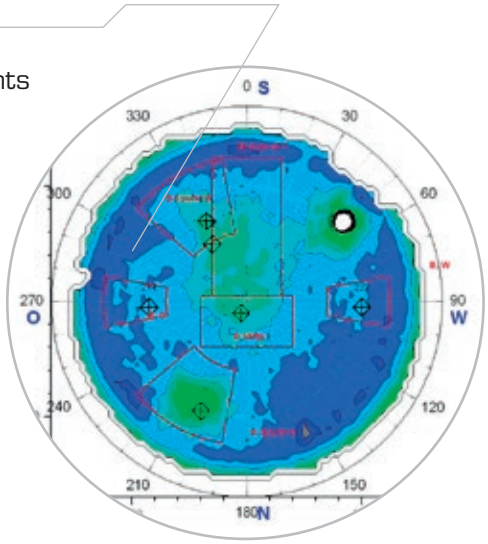
Brand name	Type of product	Al_2O_3	MgO	Fe_2O_3	CaO	110°C		1600°C	
						ccs	bd	ccs	bd
Seven Cast 90 NR 09 W -10	spinel forming vibr. castable	92,8%	4,9%	0,1%	1,0%	40	2,95	140	2,85
Seven Cast 95 NR 08 W -10	spinel containig vibr. castable	95,6%	2,2%	0,1%	1,5%	110	3,1	180	3,10
Seven Flow 92 NR 08 Z -10	spinel containig self flowing	92,1%	4,9%	0,1%	1,8%	70	2,98	>140	2,88
Seven Flow 90 NR 09 W -10	spinel forming self flowing cast.	92,8%	4,9%	0,1%	1,0%	35	2,96	>140	2,88
Seven Shot 92 NR 08 Z	spinel containig shotcrete cast.	91,7%	5,2%	0,1%	2,0%	80	2,98	150	2,92
Seven Shot 87 NR 83 H	spinel containig shotcrete cast.	87,2%	4,8%	0,1%	1,9%	45	3,06	125	3,10
Seven Shot 88 NR 08 Z	spinel containig shotcrete cast.	86,9%	5,2%	0,1%	1,9%	90	2,98	150	2,92

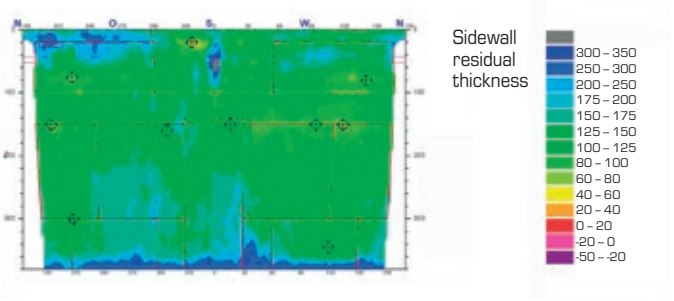
Revised 06/2019

PERFORMANCE

Low wear speed and higher performance

Regular monitoring through accurate laser scanning measurements enables effective control of the wear lining, more effective ladle management and safety. Beside that it helps to understand the wear speed which to our experience is 0,8-1 mm per heat, in average with a performance up to 150 heats campaign.



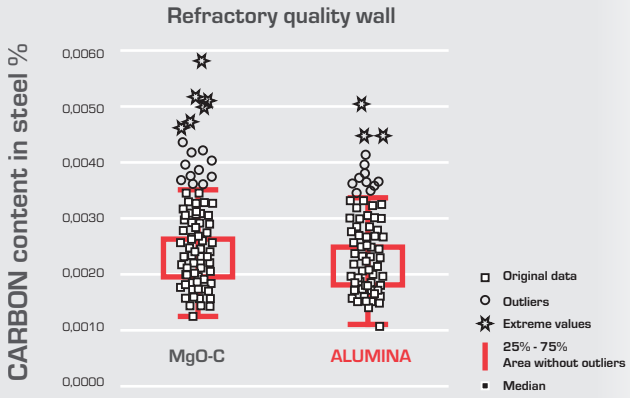


Comparison of metallurgical results between different lining concepts

Classical steel ladle bricks lining often contain graphite for its desirable thermal shock and slag corrosion resistance.

The graphite is a possible source of carbon increase in low and ultra-low carbon steels, promoting carburisation or formation of carbides inside the metal structure, this is also known as “carbon pick up”.

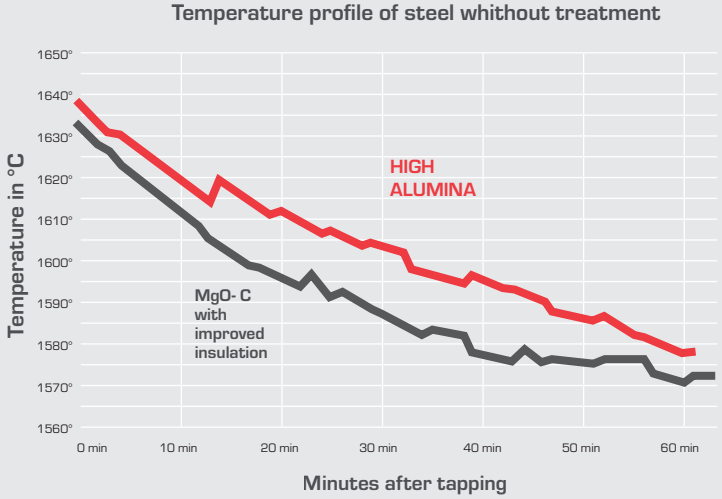
Monolithic refractories based on alumina-spinel, applied in the sidewall of the steel ladle, help to reduce the carbon pick up.



Comparison of temperature profile between different wall lining concepts

Saving energy in steelmaking is a key factor for improving the process efficiency, reducing costs and the environmental impact. It is well known that thermal conductivity of alumina-spinel refractories is considerably lower compared the MgO-C refractories.

This results in a significant lower heat loss during secondary metallurgy treatments and the option of using unshaped refractories to design a refractory lining that can optimise the capacity of the ladle.



SEVEN CAST

High alumina spinel-containing or spinel-forming high performance castable refractories

Our solutions are based on high alumina spinel-containing or spinel-forming castable materials. Both types of castable have different final properties and their use is related to the application where mainly high mechanical strength or high elasticity is demanded.

Good flow and reliable workability with low content of mixing water are the controlling factors of an easy-to-use castable allowing a uniform distribution into the molds filling even smaller gaps. In addition, it is possible to pump/transport the material at relatively large distances.

"ENDLESS" LINING

A product of low viscosity and high content of solids is achievable by accurate particle distribution of all aggregates and the right selection of deflocculant dispersing agents. The particular materials' rheology determines the perfect adhesion to the remaining brick lining allowing the concept of "endless" lining potentially reducing refractory consumption up to 30%.

LOWER WEAR RATE AND HIGHER PERFORMANCE

Regular monitoring through accurate laser scanning enables effective control of the wear lining and a more efficient ladle management and safety. Besides that, it helps to manage the wear rate (0,8 to 1mm per heat in average) with a campaign performance up to 150 heats.

SEVEN FLOW

At this point, Seven could tell you about the product special chemical composition or granulometry. This would explain the self-flowing behavior, but not the real effects yet.

While customers are initially impressed by the “magic” self-flowing behaviour of a material that seems dry, in the long run they are convinced by the technical and commercial advantages.

Facts & Figures

The steel ladle bottom is one of the most crucial parts of the entire steel operation. Some of the most modern steel plants in the world have adopted Seven Flow for the steel ladle bottom.

In a market traditionally dominated by bricks, this cutting-edge technology has shown its advantages in the recent years, getting more and more attention in the market. Especially the highly competitive and quality-oriented European steelmakers are constantly looking for an advantage in the setup of their steel ladle bottoms.

A variety of ladles up to 400 tons capacity have been successfully supplied to date.

Modern steel mills are nowadays under huge pressure to achieve highest quality products while minimizing time and respecting demanding budgets. Optimization is the leading factor, both in time and space – especially for steel ladle bottoms.

Seven Flow Advantages

Smooth, joint-free lining: Joint-free refractories substantially improve safety during steel ladle operation as they decrease the risk of leakage and infiltration into the lining.

“Endless lining”: In contrast to traditional bricks which need to be completely replaced at the ladle campaign end, an “endless” refractory layer could be simply relined when needed. These maintenance repairs only replenish what is necessary and could therefore result in substantial cost savings.

Potential increase of ladle capacity: When the walls of a ladle are installed with "Magic Flow" instead of bricks, it results on a thinner refractory layer, thus potentially increasing the ladle inner volume. Volume is also an issue when you have to build thin refractory layers gaining more productive space to be filled with steel instead. Cast after cast, day after day, the gained volume means increased steel tonnage, lower costs, better position in the market, and competitive advantage.

Improved steel production and product quality

Steel temperature is better maintained and avoids carbon pick-up due to the absence of carbon on our castable materials reducing the thermal conductivity, and contains less non-metallic inclusions thanks to the smoother surface and absence of joints on a monolithic side wall and bottom.

Usage in extreme situations:

Wherever you cannot easily apply vibrating materials, or anchoring is a barrier, or you simply have to fill every space available. What if you simply could use a castable material? Benefit from the material properties and go for the Flow alternative.

Wide range of applications: from safety lining of steel mill vessels (ladles, tundish, etc.) to the working lining, including covers, sealing elements, etc. all of them could be achieved with the help of Seven Flow.

Chemical and physical strength: High resistance to steel and slag contact, compatibility with all types of covering powders, abrasion resistance, high mechanical strength, coupled together with an enhanced ease of installation, make Seven self-flowing products the preferred material for the modern steel plants.

Seven provides suitable self-flowing refractories thanks to its continuous research and innovation on formulation as well as raw material selection.

The proper selection of granulometric spectrum and distribution, correct identification of the suitable raw materials, in combination with synergic additives, gives Seven’s self-flowing refractories the same performance as standard or vibrating castable materials, where these ones cannot (or are not suitable to) be applied.

Seven guarantees proper flowing properties, while respecting all required requirements in terms of thermal, mechanical, physical needs.

SHOT CRETING: THE REVOLUTION FOR STEEL LADLES

Shot creting for steel ladles is Seven's concept to combine the benefits of monolithic lining with those of the original brick working lining.

The repetitive application of repair layers of monolithic castable onto existing brick layers leads to unique advantages for steel makers.

With shot creting solutions by Seven Refractories, steel manufacturers benefit from increased performance and flexibility, while at the same time reducing cost.

Due to the superior physical and chemical properties of this highly developed dense castable, steel ladle management has never been as easy.

Up with Performance Down with costs

THE PROCESS

Shot creting is an installation technology combining the physical properties of high density casting materials of low, ultra-low or no cement content with pneumatic spray techniques.

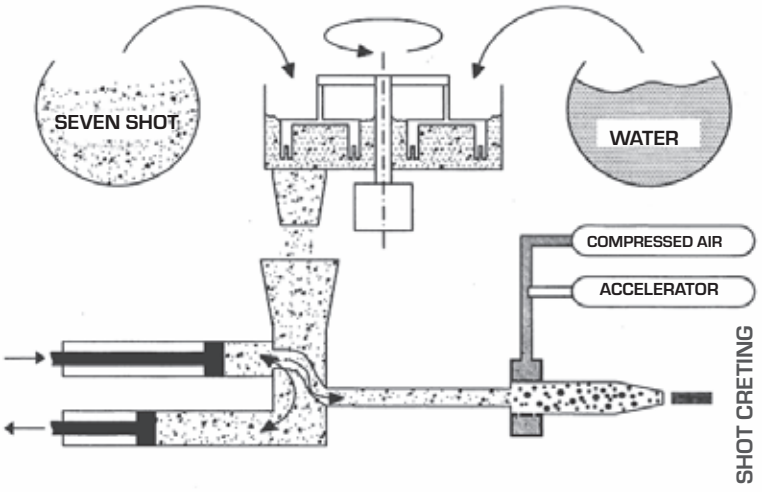
Seven Refractories guides steel manufacturers through all necessary phases:

- Product selection and preparation
- Definition of the suitable installation method
- Technology choice

SEVEN REFRACTORIES SYSTEM

- **PROJECT DEFINITION** with specific hands-on knowledge by Seven Refractories for material specification.
- **PREPARATION** of dry material mix with defined amount of water for a specified time in a mixer
- **APPLICATION** of the wet mix via a hopper with a swinging tube pump and a pipe, resulting in a highly uniform protective refractory layer
- **HIGHLY DEVELOPED EQUIPMENT FOR MIXING** and pumping ensures consistently high quality.
- **A SKILLED TEAM** of installers and supervisors delivers turn-key projects.

THE SYSTEM



Highly developed equipment for mixing and pumping ensures consistently high quality. With a skilled team of installers and supervisors, Seven Refractories is able to deliver turn-key projects.

SHOT CRETING FOR STEEL LADLES

The Product

Refractories specially developed for the shot creting technique show similar characteristics to more traditional casting mixes.
However, the specific technology involved makes shot creting outstanding in terms of time and cost reduction compared to other methods..

The Technology

By minimizing the amount of water needed, even the application onto MgO-C bricks is possible. The original brick layer is maintained and works as a “safety layer”.

Shot creting enables steel ladle management without any need for molds and additional engineering, consequently resulting in cost reduction and time saving.

Wear speed 0,8 to 1,0 mm per heat and potentially „endless“ lining, shot creting has quickly established itself as the preferred method, resulting in up to 30% cost reduction for the steel ladle lining, while increasing performance up to 50%.

THE SEVEN ADVANTAGES AT A GLANCE:

1. Usage of advanced refractory materials with low, ultra-low and no cement content
2. No need for developing and using molds
3. Increased productivity by high-performance physical properties
4. Potentially “endless” lining
5. Minimzation of dust, waste, and complications
6. Shot creting repair allows quick regeneration of the lining without its full substitution and faster return of the ladle to the operations
7. **Most importantly:**
   Up to 30% less COST,
   up to 50% more PERFORMANCE

Brand name	Type of product	Al_2O_3	MgO	Fe_2O_3	CaO	110°C		1600°C	
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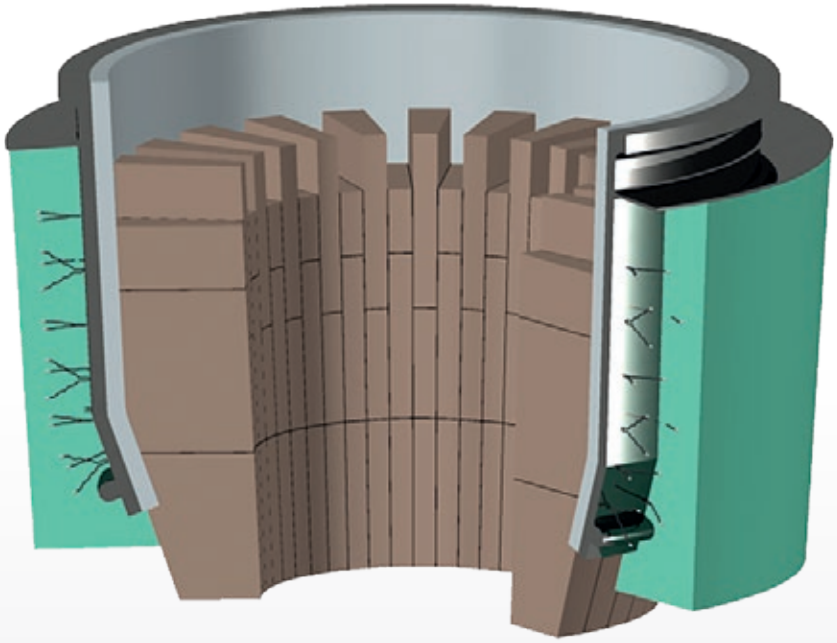
Seven Shot 88 NR 08 Z	spinel containig shot crete cast.	86,9%	5,2%	0,1%	1,9%	90	2,98	150	2,92

COMPLETE CUSTOMER SERVICE

- Preliminary study and investigation for the entire project
- Design and architecture including bill of materials and thermal calculation
- Full range of products for lining and maintenance
- Supply of mixers, gunning machines, pumps, etc.
- Training on mixing, gunning and maintenance techniques
- Training on equipment usage
- Supervision and monitoring by experienced technicians
- Global research & development
- Technical advice by experts
- Monitoring and targeting of results

STEEL TREATMENT

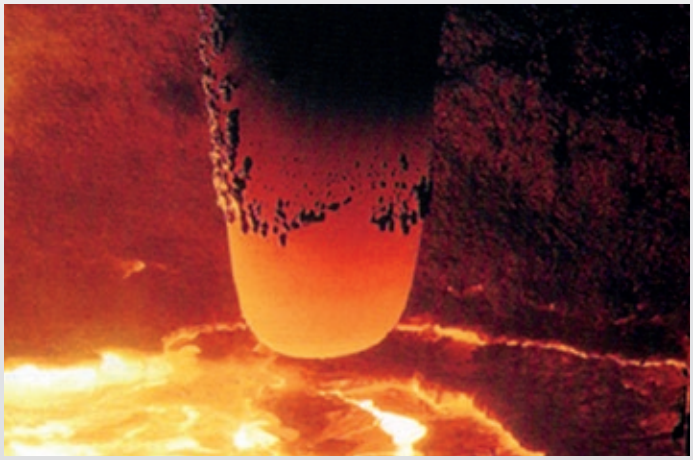
Seven Refractories provides castables and precasted solutions for steel treatment as well as for all the secondary metallurgy devices.



Quality zoning lances are designed to contrast the different wear factors.

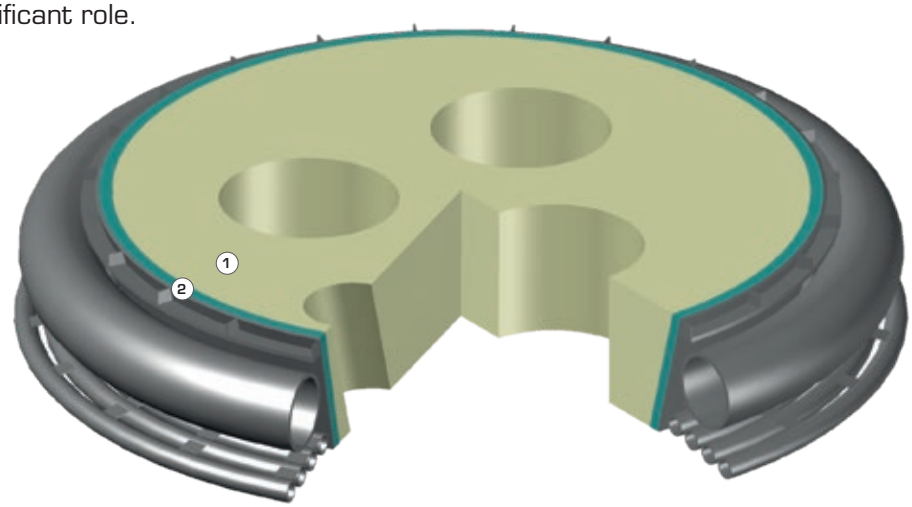
High performance products are engineered for

- Chemical attack resistance
- Abrasion resistance
- High mechanical properties
- Thermal shock resistance
- Compatibility with repairs



ELECTRIC ARC FURNACE

Among the several items influencing the efficiency and the productivity of any steel mill, surely the delta roof plays a significant role.



1
PRECASTED ROOF
HIGH ALUMINA LOW
AND ULTRA-LOW CEMENT CASTABLE/SPECIAL ADICTIVES

2
SEALING MATERIAL
HIGH ALUMINA LOW CEMENT CASTABLE

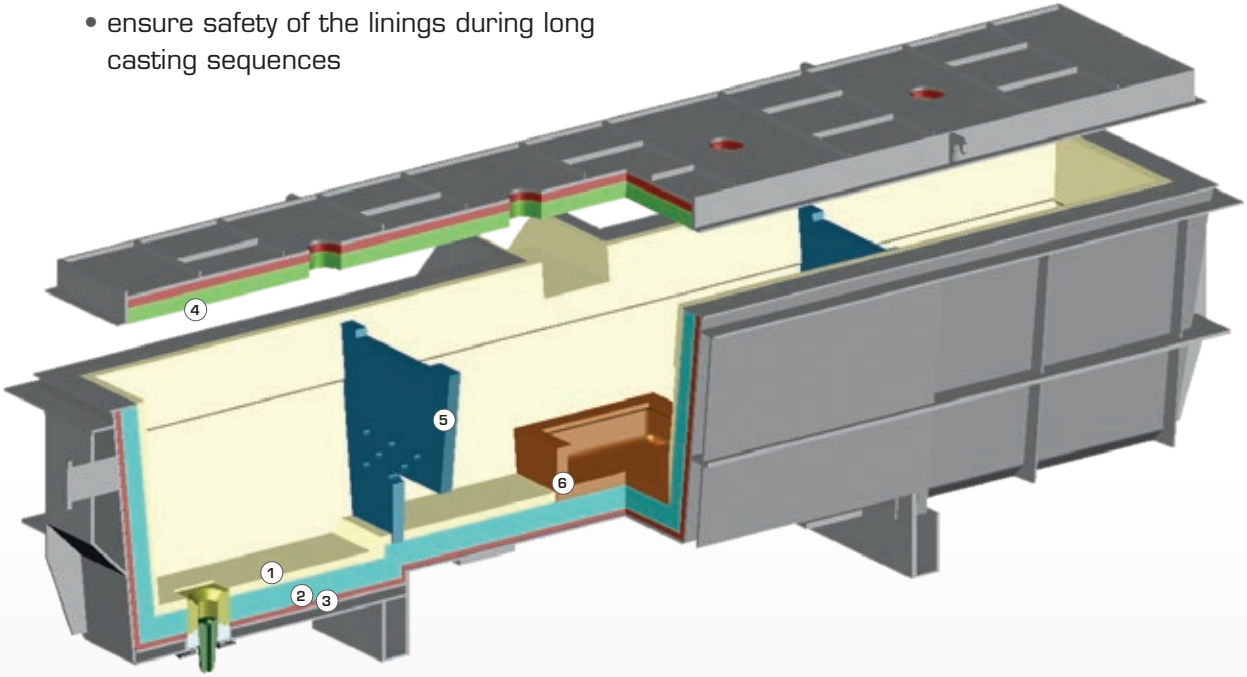
Advanced ultra-low cement product and high alumina base provide precasted blocks or casted in situ solutions for any suspended roof.

TUNDISH

Monolithic safety lining, basic spray for working lining, and precasted pieces can be manufactured in different quality grades to match different Client demands.

Seven Refractories supplies products able to:

- ensure uniformity of the steel temperature
- control turbolences and steel flow
- ensure safety of the linings during long casting sequences



1
WEAR LINING
BASIC SPRAY MIXES

2
SAFETY LINING
MEDIUM & HIGH ALUMINA LOW CEMENT CASTABLES AND SELF-FLOWING CASTABLE

3
INSULATING LINING
INSULATING SOLUTION BY BOARDS, CASTABLE OR GUNNING

4
COVER WORKING LINING
MEDIUM ALUMINA CASTABLE OR GUNNING

5
DAMS AND BARRIERS
MEDIUM ALUMINA PRECASTED PIECES

6
IMPACT PAD AND TURBOLENCE INHIBITOR
MEDIUM - HIGH ALUMINA PRECASTED PIECES

The tundish is the crucial final vessel where steel cleanness must be ensured.

SERVICES PROVIDED

- Preliminary study and investigation for the entire project
- Design and architecture including bill of materials and thermal calculation
- Full range of products for lining and maintenance
  - Regular, low, ultra-low and no-cement castable
  - Regular and dense low-cement gunning mix
  - Ramming
  - Shotcreting
  - Self flowing
- Supply of mixers, gunning machines, pumps, etc.
- Training on mixing, gunning and maintenance techniques
- Training on equipment usage
- Supervision and monitoring by experienced technicians
- Global research & development
- Technical advice by experts
- Monitoring and targeting of results

Seven® REFRACTORIES

ISO 9001 ISO 14001

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