JYOTI®
CERAMIC

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02/2018 2500 Nos.

www.jyoticeramic.com

Steatite

CERAMIC GRINDING MEDIA & MILL LINING

The best solution for
Mill lining and Grinding

JYOTI®
CERAMIC

Our Founder
Late Mr. Shyam Merani

Jyoti Ceramic Inds. Pvt. Ltd. was founded in 1970 by Late Mr. Shyam Merani, who pioneered manufacturing of industrial ceramics in India. During this journey of over 4 decades, Jyoti Ceramic Industries has garnered rich manufacturing experience and today is considered to be a leader in this field.

Our manufacturing plants are of international standards equipped with cutting edge technology and are well supported by state-of-the-art R&D laboratory and engineering workshop. We have developed many proprietary ceramic body formulations viz Zirconia, Alumina, Cordierite, Frosterite, Steatite, and manufacture a wide range of technical ceramics used for an extensive range of industrial applications. i.e. Ceramic micro, macro milling media for particle size reduction, Ball mill linings for contamination-free milling of formulations, Wear-resistant lining tiles, Blocks and coating compounds, L.T. electrical switch and fuse gear components, Heater parts, Lamp parts, Mechanical pump seal rings, and Custom ceramic components. Some of our registered leading brands are Zirconox, Zircosil, Alu-Cera, Aluma-Coat, Duralox, Zircoat, Jyodent.

We aim for excellence and are committed to manufacturing products of the highest quality at competitive prices.

State of the Art Manufacturing Unit


Sintered Media


Micro processor controlled high temp. gas fired tunnel Kiln

Wire EDM, Spark EDM


Press Shop

Steatite ceramic ball mill lining bricks and grinding media

The true value of mill lining and grinding media is measured by the length of trouble-free service in relation to its production output.

Jyoti Ceramic's Steatite grade HF 82 ceramic composite corresponds to German Steatite ceramic grade KER 221. It is a low loss, alkali free, tough, hard and dense ceramic.

Physical properties

Property	Units	
Colour	---	Off white
Density	g/cc	2.70 ± 0.05
Bulk density	kg/Litre	1.60 ± 0.05
Water absorption	%	0.00
Flexural strength	Mpa	130
Compressive strength	Mpa	850
Vicker's hardness	$Hv_5(kg/mm^2)$	520 - 550
Hardness on Moh's scale	---	7
Co-efficient of linear thermal expansion (20 °C - 1000 °C)	X 10^{-6}/°C	8.5
Safe operating temperature (No load)	°C	1,050
Volume resistivity (20 °C)	Ω - cm	10^{13}
Cum, wear loss/hr after 120 hrs of wear test	%	0.025

Chemical properties

Oxides	%
SiO_2	61.5%
MgO	27.4%
BaO	3.2%
Al_2O_3	6.8%
Fe_2O_3	0.5%
Na_2O	0.1%
CaO	0.5%

*Steatite ceramic is resistant to all acids and alkalis except Hydrofluoric Acid.

Versatile Industrial Applications of Steatite Grinding Media


Paper Pulp Industry

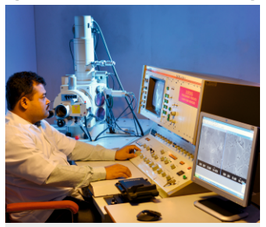

Rubber / Latex Industry


Paints


Minerals


Inks

Jyoti Research & Development at Glance

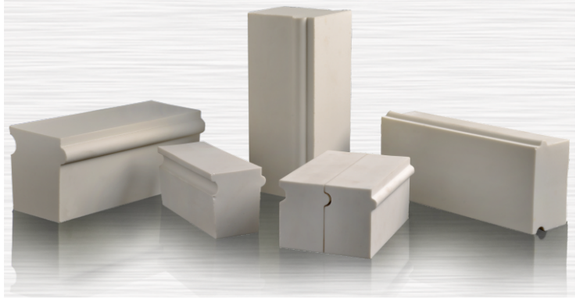

Scanning Electron Microscope (S.E.M.)


Energy Dispersive X-ray Fluorescence Spectrometer (E.D.X.R.F.)


Atomic absorption spectrophotometer (A.A.S.)


Roundness Tester

Steatite ceramic tapered & flat mill lining bricks

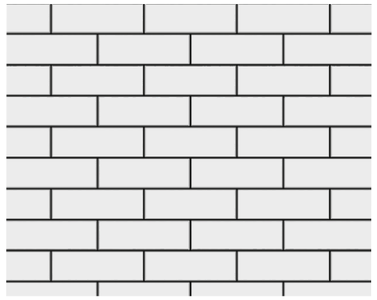


Steatite ceramic mill lining bricks protect the steel ball mill shell & provide high purity grinding. They come with a tongue & groove design to form an interlocking pattern during installation. This ensures bricks are fixed firmly in a mill shell and in end flanges with a minimum quantity of fixing adhesive / cement. Interlock fixing of bricks prevent them from giving way from installation, chipping off and spalling off edges. Steatite mill lining bricks are available in a wide range of sizes and thickness to suit small and large size ball mills.

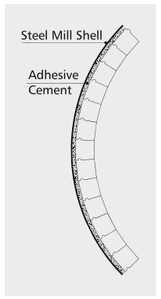
Following features and benefits are worth considering using Jyoti's Steatite ball mill linings for milling substances of hardness below 7.0 on Moh's Scale.

- Chemically inert and will not react when exposed to chemicals except Hydrofluoric Acid.
- Lower in cost as compared to alumina ceramic.
- Wear rate of the Lining is negligible and more constant as compared to traditional ceramic lining materials.
- Dimensional stability : Steatite ceramic mill lining bricks are uniform and stable in dimensions.
- Easy to machine, chip or grind: any skilled or semiskilled mason can easily and speedily carry out the installation of lining in the ball mill under the supervision of a civil / mechanical engineer.
- Hard and tough, resists high impact, high abrasion, and corrosion wear.
- Has higher temperature resistance than steel, rubber, polyurethane, natural stone, and other conventional mill lining materials.
- Substantial increase in mill volume due to lesser thickness as compared to traditional stone lining.

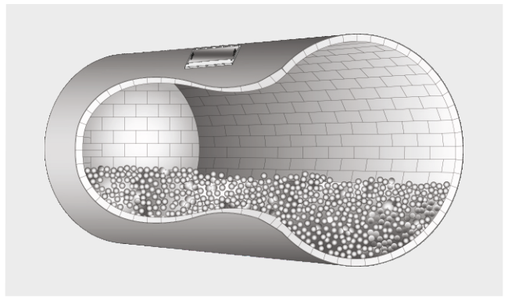
High production capacity :
A strong thin Steatite ceramic lining brick increases the working volume in a mill than thick natural stone lining blocks. In a 1800 mm Ø x 1800 mm L ball mill, a 65 mm thick Steatite brick lining will increase mill working volume by 25%, than the 125 mm thick conventional natural stone lining blocks.



Recommended Staggered Lining Pattern



Mill Shell Lined with All Tapered Bricks



Ball Mill Lined with Bricks

Calculations for lining bricks

To calculate lining for a cylindrical mill (flanges are lined first and feed door openings are not considered).

Formulae to be used are:

1. Straight bricks for flanges

$$N1 = \frac{1.5715 \times D^2}{a1 \times b1}$$

Where: N1 = Number of straight bricks
a1 = Length of straight brick in cm
b1 = Width of straight brick in cm
D = Internal diameter of mill in cm

2. Tapered bricks for cylindrical face

$$N2 = \frac{3.143 \times D \times L \text{ Nos}}{a2 \times b2}$$

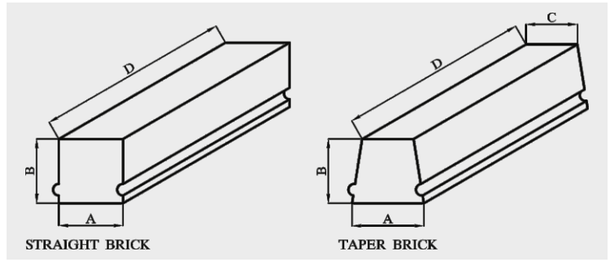
Where: N2 = Number of tapered bricks
a2 = Length of tapered brick in cm
b2 = Width of tapered brick in cm
D = Internal diameter of mill in cm
L = Internal length of the mill after lining in cm

Example : To calculate the number of bricks required for Ø 6' x 6' Long (Ø 180 cm x 180 cm Length) cylindrical ball mill (flanges are lined first).

Here: a1 = a2 =150 mm =15 cm
b1 = b2 = 50 mm = 5 cm
D = 180 cm
L = 170 cm

Therefore $N1 = \frac{1.5715 \times 180 \times 180}{15 \times 5} = 679$ Nos

$N2 = \frac{3.143 \times 180 \times 170}{15 \times 5} = 1283$ Nos



Steatite Ceramic Ball Mill Lining Brick

Dimensional tolerances ±0.5 mm or 2.0% whichever is greater, Bow allowance maximum 0.5% of length.

Dimensions and weights of standard size mill lining blocks

Block number	Dimension in millimeters				Approximate weight in kgs	Suitable for ball mill size
Taper	**A**	**B**	**C**	**D**		
C - 32	40.0	47.0	32.0	100	0.465	Ø 457 mm to 762 mm (18" Ø to 30" Ø)
C - 51	59.5	65.0	51.5	150	1.400	900 mm Ø (3' Ø)
C - 53	59.5	65.0	53.5	150	1.450	1200 mm Ø (4' Ø)
C - 54	59.5	65.0	54.5	150	1.470	1524 mm Ø (5' Ø)
C - 55	59.5	65.0	55.5	150	1.450	1830 mm Ø (6' Ø)
Straight						
B - 30	50.0	30.0	- -	100	0.400	For mill end lining: Ø457 mm to 762 mm (18" Ø to 30" Ø)
B - 32	32.0	47.0	- -	100	0.400	- - -
B - 42	65.0	42.0	- -	150	1.070	For mill end lining: Ø900 mm to 2133 mm (3' Ø to 7' Ø)
B - 53	53.3	65.0	- -	150	1.360	- - -

Steatite Ceramic Grinding Media

Steatite ceramic grinding media and ball mill lining bricks is manufactured from the same fine-grained composite and are ideal performance partner. Thus, they retain their shape better and last longer than flint / river pebbles, natural stones, porcelain etc. Due to their higher density, hardness, toughness and a higher degree of sphericity, Steatite ceramic grinding media saves over 20-25% milling time than river pebbles.

Advantages of Steatite Ceramic Grinding Media :-

Higher density, hardness & sphericity As compared to flint river pebbles and natural stone.

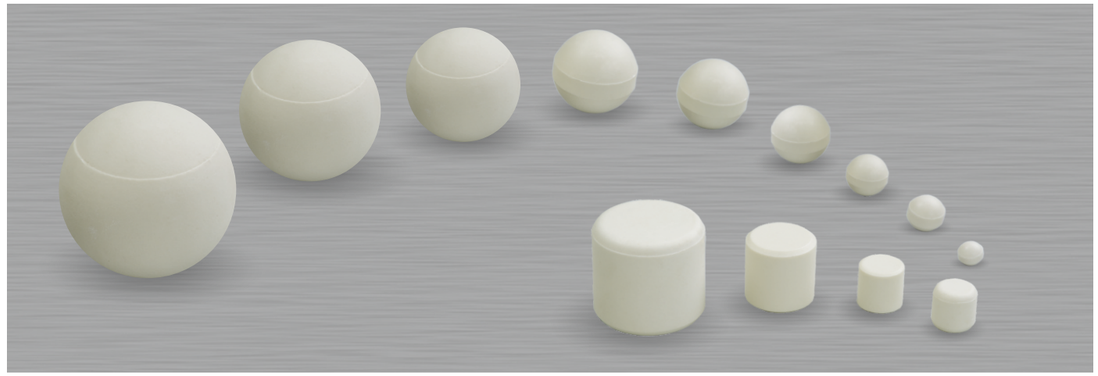
Easy to use : Steatite grinding media is fully vitrified, non-porous and satin smooth in surface finish, allowing easy and thorough cleaning while changing the charge from one colour shade to another.

Longer milling life : As Steatite grinding media have dense homogeneous internal microstructures, it offers superior wear resistance as compared to other conventional media.

Low contamination with high levels of homogeneity wear rate of our Steatite grinding media is so insignificant, that it has no effect on the colour & composition of the end milled product.

Wide range of sizes : Steatite satellite type grinding media is available in 8 assorted sizes Ø 6, 8, 10, 12.5, 15, 20, 25, 30 and Isostatic (ISO) pressed media 40, 50 & 60 mm diameter to meet the most demanding applications for dispersion and particle size reduction.

Uniform quality : Steatite grinding media is produced in the most modern plant under stringent quality control checks at various stages of manufacturing to ensure consistency in quality and elevate the grinding media to the highest quality level.



Types of Steatite Grinding Media

Steatite ceramic spherical & cylindrical grinding media for various types of mills.

Ball mills are the most commonly used mills to accomplish particle size reduction. A revolving vessel, the 'drum', lined with ceramic bricks contains grinding media and the raw material to be ground.
Ball mills are classified into :-

Batch type & Continuous type :

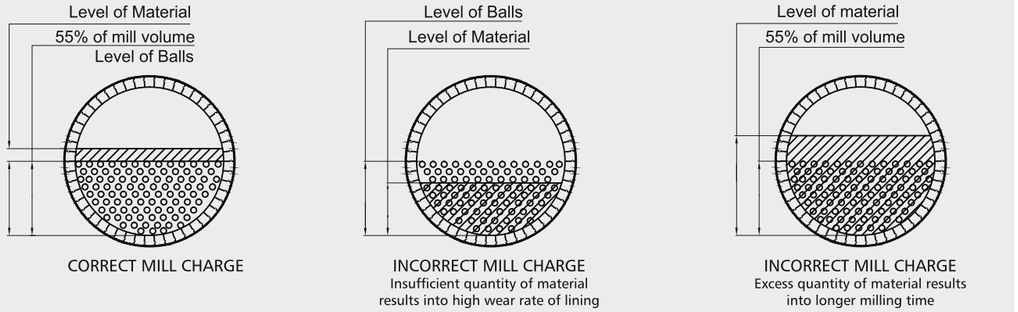
Batch type ball mills are versatile and most widely used. Particle size reduction takes place by impact on the material with the tumbling grinding media and by abrasion between the media and the mill wall.

Selection of grinding media

For a fresh charge, it is the most general practice to use three different ball sizes: 25% of large size, 50% of medium size & 25% small size. There might be cases where using 2 to 4 different size of grinding balls may be necessary. This will require a change in the proportions of each size used. For topping of the mill, we suggest a selection of the largest dia balls.

Recommended charge of material to be ground and grinding media.

Charge of material to be ground : There are no hard and fast rules about charging of mills; some general rules are adopted from experiences of operators which helps in achieving optimum milling efficiency at economical cost. In most cases, the quality of material to be ground should be 25-30% of mill's useful volume. Non-obersvance of these limits can lead to high wear rate of grinding media and the mill lining or to a considerably longer grinding time.



Recommended quantities of grinding media:-

To obtain optimum grinding efficiency, we recommend:

1) For batch type mill: Grinding media should fill 55% of mill's useful volume.
2) For continuous type mill: Grinding media should fill 35% of mill's useful volume.

To calculate media charge for cylindrical mill. Formula is given below:

Where: M = Weight of the grinding media charge in kgs
D = Mill internal dia in cms after lining
L = Internal length of the mill in cms after lining

For batch type ball mill:

$M = 0.000691 \times D^2 \times L$

Example: To calculate grinding media charge for a Steatite brick lined batch type mill size: Ø 6' x 6' Long (Ø 180 cms x 180 cms L) (Mill openings are not considered).

Thickness of tapered brick = 6.5 cm
Thickness of straight brick = 4.2 cm

Therefore D = 180 – 13 = 167 cm
L = 180 – 8.4 = 171.6 cm
$M = 0.000691 \times 167^2 \times 171.6$

Grinding media quantity = 3307 kg

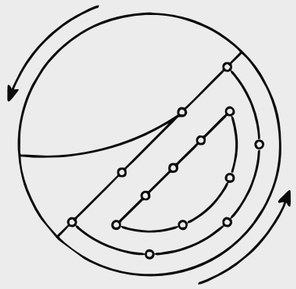
Ball mill volume, media charge & RPM

No.	Mill I.D.		Lining thickness	Usable volume of mill	Media qty @ 55% vol	Media size and quantity	Speed
	mm	inch	mm	Ltr	kg	mm	rpm
1	450	18	Taper : 47 Straight : 30	38.8	34	50% Ø 20 mm + 50% Ø 25 mm	37 - 38
2	600	24	"	108.6	95	50% Ø 25 mm + 50% Ø 30 mm	32 - 33
3	750	30	"	233.3	205	50% Ø 25 mm + 50% Ø 30 mm	30 - 31
4	900	36	Taper : 65 Straight : 42	380.2	334	25% Ø 25 mm + 50% Ø 30 mm & 25% Ø 40 mm	27 - 28
5	1050	42	"	642.4	565	25% Ø 25 mm + 50% Ø 30 mm & 25 % Ø 40 mm	25 - 26
6	1200	48	"	1004	883	25% Ø 25 mm + 50% Ø 30 mm & 25% Ø 40 mm	23 - 24
7	1350	54	"	1480.6	1303	25% Ø 30 mm + 50% Ø 40 mm & 25% Ø 50 mm	21 - 22
8	1500	60	"	2088.3	1837	25% Ø 30 mm + 50% Ø 40 mm & 25% Ø 50 mm	20 - 21
9	1800	72	"	3760.4	3309	25% Ø 30 mm + 50% Ø 40 mm & 25% Ø 50 mm	18 - 19

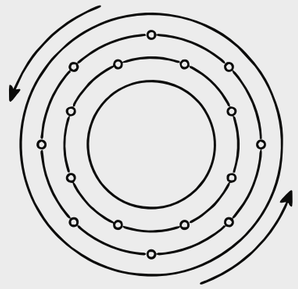
Recommended mill rotation speed :

Mill rotating speed is an important parameter for optimizing grinding efficiency.

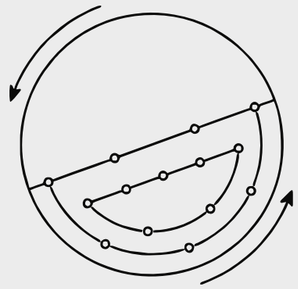
- Using proper speed has a cascading effect where the charge and grinding balls roll over one another, thus developing maximum milling action with minimum wear of grinding media and lining.
- If the ball mill rotates at an excessive speed, there will be centrifugal effect and no particle size reduction will take place.
- If the speed is too slow it results in purring effect where the charge is lifted to small angle and balls tend to slide back on the lining hence the grinding action is poor.



CORRECT
Operational Speed
Cascade Effect
Efficient Grinding



INCORRECT
Excessive Speed
Centrifugation
No Grinding



INCORRECT
Very Low Speed
Purring Fall
No Grinding

Calculations for mill motor power & mill speed

Considering the weight of mill lining and grinding media, work out the motor power required in consultation with the mill manufacturer.

To calculate the motor power required for a cylindrical type ball mill, the following formula can be applied:

$$W = 0.04116 \times D^3 \times L \times n \times (0.6d + 0.4d1)$$

Where: W = Required motor power in HP
D = Internal Ø of the mill in mtrs
L = Internal length of the mill in mtrs
d = Specific gravity of grinding media
d1 = Specific gravity of substance
n = Speed of ball mill in rpm

Example: Let the internal Ø of the mill be 1.8 mtrs and internal length be 1.8 mtrs. If Steatite grinding media is used then density d = 2.7. If milling substance is Steatite in slurry form with around 70% solids, then density d1 = 1.6

d = 2.7 and d1 = 1.6 then

$$W = 0.04116 \times (1.8)^4 \times 19 \times (2.7 \times 0.6 + 1.6 \times 0.4) = 18.5 \text{ hp}$$

To calculate the speed of the mill, use the following formula:

$$Nc = \frac{76.6}{D^{1/2}}$$

Where: Nc = Critical speed
D = Internal Ø in ft.

Actual speed of the mill should be approximately 62% of the Nc for wet milling and 75% of Nc for dry milling.

Table indicating the optimum mill speed and motor power of ball mill

Inside	Inside	Dry grinding with Steatite media		Wet grinding with Steatite media	
Dia (mm)	Length (mm)	Speed (rpm)	Motor power (hp)	Speed (rpm)	Motor power (hp)
300	300	60	1/2	46	½
450	450	50	1/2	37	½
600	600	43	1	33	1
750	750	39	1 ½	29	1 ½
900	900	35	2 ½	27	2 ½
1050	1050	33	5	25	4 ½
1200	1200	31	7 ½	23	6 ½
1350	1350	29	12	22	8
1500	1500	27	15	21	12
1800	1800	25	25	19	20
2100	2100	23	37	17	30
2400	2400	22	55	16	45
2700	2700	20	90	15	75
3000	3000	19	125	15	100

Jar mills : Particle size reduction takes place by impact over the material with the tumbling grinding media and by abrasion between the media and the mill wall. It works on the same principle as batch type ball mills.

Recommended grinding media : Balls of Ø 12.5mm to 20mm.

Attritor mills : Particle size reduction takes place by wet milling. In this process, the media is agitated with a series of stirring arms or disc mounted on vertical axial shaft.

Recommended grinding media : Ball of Ø 6mm / 8 mm / 10 mm & 12.5 mm.

Recommended media charge : 70 - 75% of mill's useful vol.

Calculation of media load :

Example :

Attritor mill net volume is 50 Ltr charging with Ø 8 mm balls. 70% of mill's vol = 35 Ltr x 1.6 kg/Ltr (bulk density of Steatite media).

That is 56 kg of Steatite grinding media is required for 50 Ltr capacity attritor mill.

Vibro mills : For grinding and producing fine particle size less than 1 micron in a cost effective manner. Since high impact like conventional costly ball mills are not required in vibro mills. Instead a large number of low energy impacts are necessary using small grinding media with high vibration or rotation rate.

Recommended grinding media : Cylinders of Ø 6.0 mm to Ø 20.0 mm.

Recommended media charge : 60 - 70% of mill's useful vol.

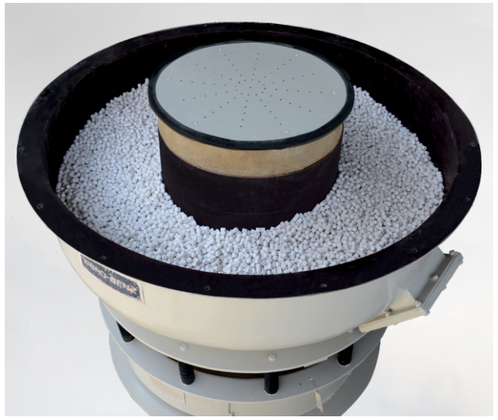
Calculation of media load

Example :

Vibro mill net volume is 350 Ltr charging with Ø 12.5 mm cylinders.

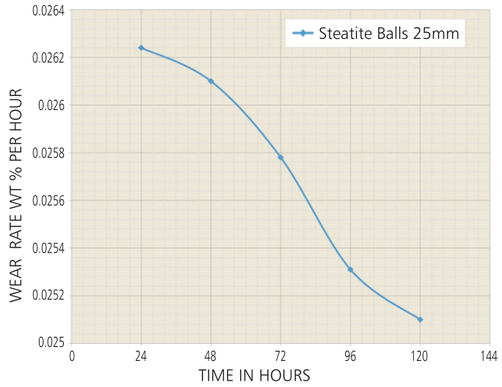
60% mill's vol = 210 Ltr x 1.6 kg/Ltr (Bulk density of Steatite media)

That is 336 kg of Steatite grinding media required for 350 Ltr capacity Vibro mill.

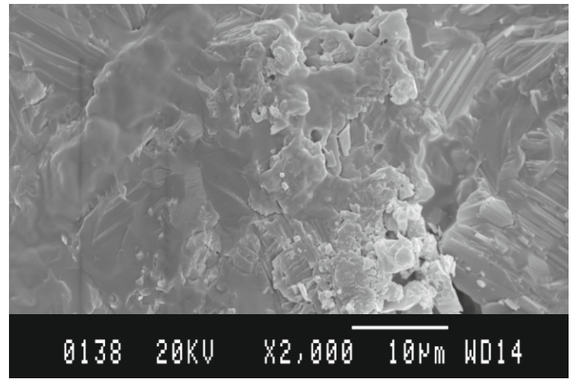


Wear rate

Wear rate V/s milling time



Micrograph



Wear rate test procedure

Jar mill	20 Ltr capacity rubber lined
Speed	30 rpm
Grinding media charge	Steatite ceramic grinding media Ø 25 mm and quantity 50% of jar mill's useful volume
Material charge	5 kg silica sand of 0.3 mm size
Water	5 Ltr

Grinding media is weighed on an electronic balance of 10 mg resolution & milled for 24 hrs after being loaded into the jar with material, charge, and water. After milling, grinding media is unloaded, washed, dried thoroughly and weighed again and weight loss percentage per hour is calculated. This process is repeated every 24 hrs for a total of 120 hrs. Graph of wear rate versus time is drawn. It is inferred from the graph that the wear rate reduces with time upto 0.025% per hour for Steatite grinding media and then remains almost constant.

Mode of packaging :

- Ceramic macro grinding media are packed in strong double lined HDPE plastic bags.
- Each bag contains grinding media of net weight 25 kg / 50 kg.
- For exports, these HDPE plastic bags are re-packed in strong, sea-worthy wooden pallet type crates.