



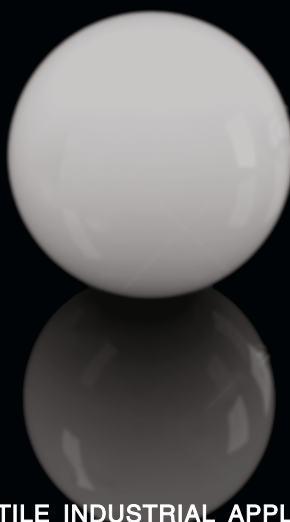
ZIRCONIUM SILICATE MICRO MILLING MEDIA

Upper Medium Density ($\geq 4.4 \text{ g/cm}^3$)

Milling Medium - Low

Viscous Formulation

Cost-effective



VERSATILE INDUSTRIAL APPLICATIONS



MINERALS



WATER-BASED PAINTS



PRINTING INKS



TEXTILE DYES



AGRO



ZIRCONIUM SILICATE
MICRO-MILLING MEDIA

Zircosil is the registered name of Jyoti Ceramic Industries Pvt. Ltd. for their proprietary formulated Zirconium Silicate composite, specially developed upper medium-density (4.4 g/cm³) ceramic micro milling beads used for wet milling/dispersion of formulations.

Looking at the market needs for medium density, long-lasting, cost-effective ceramic milling beads, we started extensive research to develop suitable ceramic milling beads for the specific segment of customers who have bead mills but are not suitable to carry the load of Zirconox high density (6.2 g/cm³) beads. We finally succeeded in developing sintered Zircosil ceramic micro milling beads.

Generally, for dispersion or particle size reduction of substances, ceramic-glass beads are used the world over in bead mills, pearl mills, or in agitating attritor mills. Zircosil beads can conveniently replace glass and most of ceramic beads due to their superior features and cost economics. Zircosil beads are most ideally suited for dispersion and micro-fine milling of low and medium-viscous formulations.

CHEMICAL PROPERTIES

ZrO ₂	: 60%
SiO ₂	: 30%
Others	: 10%

PHYSICAL PROPERTIES

Colour	: Light Grey
Surface Finish	: Glossy, Satin Smooth
Density	: 4.4 ± 0.05 g/cm ³
Bulk Density	: 2.70 ± 0.05 kg/ltr
Porosity	: Nil
Water absorption	: 0 %
Hardness on Mohs scale	: 9
Hardness on Vickers Scale	: 1100 - 1150 Hv _s
Flexural Strength 3 P.B. (@ Room Temp.)	: 160 MPa
Compressive Strength (@ Room Temp.)	: 450 MPa
Young's Modulus	: 100 GPa
Crushing Strength (@ R. Temp. Ø1.5mm bead)	: 72.5 kgf
Bead Sphericity 90%	: ≥0.95
% Cumulative Weight Loss / Hr (Wear test conducted in high-speed bead mill @ 3000 rpm with water. Bead size Ø 1.2-1.7 mm)	
After 24 Hrs.	: 0.0063
After 96 Hrs.	: 0.00582
Max Temperature of use (No Load Condition)	: 1350 °C (2462 °F)

Zircosil ceramic beads are :

- Non-contaminative
- Non-radioactive
- Chemically inert
- Non-toxic
- Non-magnetic
- Resistant to all acids and alkalis except for hydrofluoric acid.



APPLICATION OF ZIRCOSIL MICROBEADS

Zircosil microbeads are being used in varied industries for micro-fine wet milling & dispersion of :

Agrochemicals: Fungicides, Herbicides, Pesticides.

Dyestuff: Textile dyes, Textile Inks.

Cosmetics: Pigment colours for colour cosmetics and personal care products.

Food Stuff: Spices & herbs grinding, Soyabeans.

Inks: Printing inks, Inkjet - Magnetic inks, Tattoo inks, Rotogravure inks, Flexographic inks.

Minerals: Calcium Carbonate, Talc.

Oxides: Titanium Dioxide.

Paints & Varnishes: Auto & allied paints, Decorative & Marine paints.

Pharmaceuticals: Nanosizing of pharmaceutical slurries.

Zircosil beads are also used for shot peening treatment on metal surfaces, metal polishing, contact eye lenses polishing and a host of many other applications.

CERTIFICATE

Fraunhofer Institut
Verfahrenstechnik und Verpackung

Food regulatory assessment of Zircosil® milling beads

Auftraggeber : JYOTI Ceramic GmbH, 90429 Nürnberg

Auftrag : PA/4339/08

Probe : Zircosil® milling beads 0.4 -0.7 mm

The investigated milling beads are intended to be used for wet-micro-milling in pearl mills for multiple use applications. The general bead charge is approx. 70% beads / 30% mill material (v/v). As a worse-case condition for selection of the migration test condition, 2 h grinding time at 70 °C were assumed.

Migration testing was carried out with the smallest beads 0.4 - 0.7 mm which is the application with the largest surface-volume ratio. Therefore, the results can be transferred to bigger beads.

Migration of main metal components (zirconium and cer) as well as further elements (Ag, As, Au, Ba, Be, Bi, Cd, Co, Cr, Cs, Cu, Hg, Li, Mn, Mo, Ni, Pb, Pt, Sb, Se, Sn, Sr, Te, Ti, Tl, U, V, W, Zn) were analyzed after migration contact of 2 h at 70 °C with 3% acetic acid (70% bead charge). Since the beads are multiple-use applications, migration tests were carried out three times on the same samples in series, using a fresh food simulant portion each time. The third migration contact was used for evaluation according to the European Plastics Directive 2002/72/EC Annex 1.5 (test report PA/4339/08 DATED 16.9.2008).

The migration of the investigated metal components complies with the limits and references laid down in the EU Plastics Directive 2002/72/EC (last amendment by Directive 2008/39/EC), in the Council of Europe Resolution AP (92)2 as polymerisation aids technical adjuvants, in the Drinking Water Health Advisories (2006) of the U.S. Environmental Protection Agency (EPA) and of World Health Organisation (WHO), respectively.

Therefore Zircosil® milling beads may be used in multiple-use applications in micro-milling for all types of food.

Fraunhofer Institute Process Engineering and Packaging

Freising, 15.10.2008

Dr. Angela Störmer
(Head of Laboratory)

Annika Seiler
(Scientist)

Fraunhofer Institut für Verfahrenstechnik und Verpackung, Gliggenhauser Str. 35, D-85354 Freising

Fraunhofer Institute, Freising, Germany has approved Zircosil ceramic micro milling beads for milling of food in accordance with the regulations of the European Community.

BENEFITS OF USING ZIRCOSIL
MICROBEADS

Zircosil beads, are of upper medium-density (4.4 g/cm³) tough and sapphire hard (9 Moh's scale), ideally suited for speedy dispersion/milling of hard and soft substances in high-low speed, horizontal and vertical type bead mills, attritor, turbo, and pearl mills.

- Zircosil beads being of low co-efficient of friction, having glossy satin-smooth surface are most gentle to expensive mill parts.
- Zircosil beads are free from pinholes, cracks, and beads fused with other beads, resulting in reduced downtime and greater process safety. During a change of formulation process, cleaning and washing of beads are faster & less cumbersome.
- Zircosil microbeads are sintered at 1400 °C, have a dense and homogeneous internal microstructure, due to which the beads maintain a satin-smooth surface finish and do not crack or shatter easily.

CHEMICAL RESISTANCE DATA OF
ZIRCOSIL MICROBEADS AT
25°C TEST TIME 24 HRS.

Chemical Medium	Concentration	% Weight Loss per hour
Acetic Acid (CH ₃ COOH)	50%	0.00
Chromic Acid (H ₂ CrO ₄)	25%	0.00
Formic Acid (CH ₂ O ₂)	25%	0.00
Hydrochloric Acid (HCl)	18%	0.00
Hydrofluoric Acid (HF)	24%	0.12
Nitric Acid (HNO ₃)	35%	0.00
Perchloric Acid (HClO ₄)	25%	0.00
Phosphoric Acid (H ₃ PO ₄)	25%	0.00
Sulphuric Acid (H ₂ SO ₄)	50%	0.00
Saturated Sodium Hydroxide Acid (NaOH)	50%	0.00

** With the exception of Hydrofluoric acid Zircosil beads maintain their integrity.*



VARIOUS MILLS SUITABLE
FOR ZIRCOSIL BEADS



GUIDELINES FOR USING ZIRCOSIL MICRO MILLING BEADS

- To avoid fracture, shearing, flattening of beads, ensure that the gap between the mill chamber walls including the bottom of the mill vessel to the agitating stator arm is maintained to a minimum of 3 to 5 times larger than the largest bead size.
- To avoid passage of beads in the slurry ensure that the size of strainer aperture is minimum 2 times smaller than the average size of beads.
- Before charging the mill with Zircosil beads, it is strongly recommended to thoroughly check the capacity and volume of the bead mill chamber to assess the right quantity of Zircosil beads required for the mill
(i.e. 60 to 85% volume of mill X packing density of Zircosil beads = Quantity).

CALCULATION OF MEDIA LOAD

Type of Mill	Bead Charge
Closed Horizontal	75% - 85% of Volume
Closed Vertical	70% - 80% of Volume
Open Vertical	60% - 70% of Volume

E.g.: Bead mill net volume capacity is 50 ltr. Charging with Ø 1.2 - 1.7 mm bead. For closed vertical type mill, it works out to = 35 ltr (70% of mill vol.) x 2.70 kg/ltr (Packing density of Zircosil beads). That is 95 kg Zircosil bead charge required for a 50 ltr capacity closed vertical mill.

ZIRCOSIL BEAD CHARGE WEIGHT SUGGESTED FOR DIFFERENT CAPACITY MILLS

Considering beads Ø 1.2 - 1.7 mm & bead charge of 75-85% of the volume of the grinding chamber for a closed horizontal mill, 70-80% of volume for closed vertical mill & 60-70% of volume for open vertical mill.

VOLUME OF GRINDING CHAMBER (LTR)	QTY. OF ZIRCOSIL MICRO BEADS (KGS)		
	FOR CLOSED HORIZONTAL MILL	FOR CLOSED VERTICAL MILL	FOR OPEN VERTICAL MILL
8.0	16 - 18	15 - 17	13 - 15
15.0	30 - 34	28 - 32	24 - 28
30.0	61 - 69	57 - 65	49 - 57
45.0	85 - 91	85 - 97	73 - 85
60.0	121 - 138	113 - 130	97 - 113
115.0	233 - 264	217 - 248	186 - 217
225.0	456 - 516	425 - 486	365 - 425

ZIRCOSIL BEADS ARE AVAILABLE IN THE FOLLOWING FRACTION SIZES

Broad Fraction Size	
Ø 0.4 - 0.7 mm	Ø 0.7 - 1.2 mm
Ø 1.2 - 1.7 mm	Ø 1.7 - 2.4 mm
Ø 2.4 - 2.8 mm	Ø 2.8 - 3.3 mm
Narrow Fraction Size	
Ø 0.4 - 0.6 mm	Ø 0.6 - 0.8 mm
Ø 0.8 - 1.0 mm	Ø 1.0 - 1.2 mm
Ø 1.2 - 1.4 mm	Ø 1.4 - 1.6 mm
Ø 1.6 - 2.0 mm	Ø 1.8 - 2.0 mm
Ø 2.0 - 2.4 mm	Ø 2.6 - 3.0 mm
Ø 3.5 - 4.0 mm	

* We also offer custom fraction size beads, if found feasible for production.

ZIRCOSIL BEADS BULK DENSITY

Dia (mm)	kg/ltr
Ø 0.40 - 0.70 mm	2.70 ± 0.05 kg/ltr
Ø 0.70 - 1.20 mm	2.70 ± 0.05 kg/ltr
Ø 1.20 - 1.70 mm	2.70 ± 0.05 kg/ltr
Ø 1.70 - 2.40 mm	2.75 ± 0.05 kg/ltr
Ø 2.40 - 2.80 mm	2.75 ± 0.05 kg/ltr
Ø 2.80 - 3.30 mm	2.75 ± 0.05 kg/ltr

DETAILS OF BEAD MILL USED FOR CONDUCTING THE WEAR TEST

Mill Type	Horizontal Closed Bead Mill	Make	NETZSCH, Germany
Model	LME - 1	Mill Container	Polyurethane
80% of Mill Volume	0.61 Ltr	Mill Agitator Speed	3000 RPM
Ceramic Media (Qty.)	1.65 kg.	Media (Milled with)	Water

After milling for 24 & 96 hours at 3000 RPM (10.0 m/s), beads were collected, washed and dried thoroughly, weighed on sensitive electronic balance (Resolution: 100 mg) & the percentage weight loss was calculated as.

$$P = \frac{W1 - W2}{W1} \times 100\%$$

Where
P = Percentage Weight Loss
W1 = Initial Weight of Beads
W2 = Final Weight of Beads

The weight loss of Zircosil microbeads was found insignificant as well as caused the lowest wear on mill contact parts. The percentage cumulative weight loss of Zircosil beads was observed to be 0.0063% per hour in the 24-hour test. The percentage cumulative weight loss reduced down to 0.00582% per hour in 96-hour test.

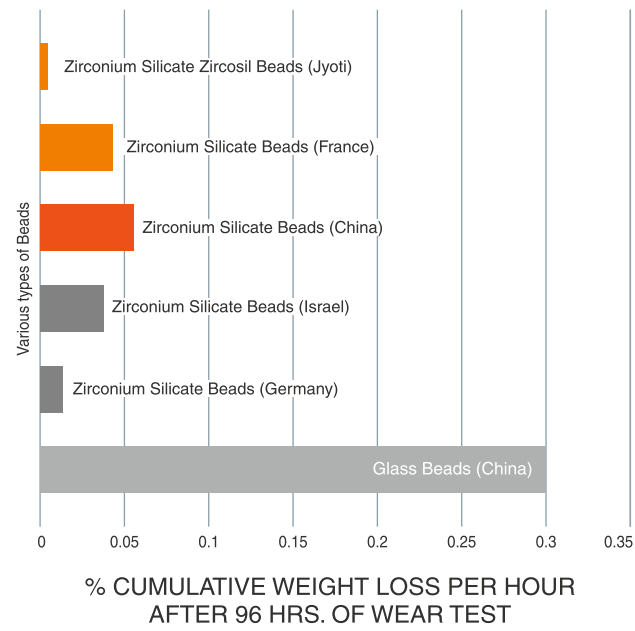


High Speed Bead Mill for Wear Test

COMPARATIVE TYPICAL PROPERTY AND WEAR RATE CHART

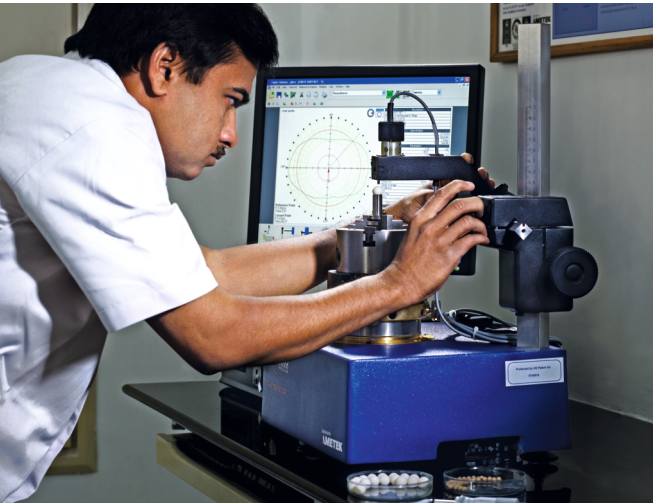
CHARACTERISTICS	UNITS	ZIRCONIUM SILICATE BEADS					GLASS BEADS
		JYOTI (ZIRCOSIL)	FRANCE	CHINA	ISRAEL	GERMANY	
Colour Shade	--	Light Grey	Off White	White	White	Off White	Transparent
Density	g/cm³	≥ 4.4	3.84	3.75	4.08	4.13	2.25
Bulk Density	kg/ltr	2.70 ±0.05	2.44	2.38	2.47	2.46	1.55
Porosity	%	0.00	0.00	0.00	0.00	0.00	0.00
Water Absorption	%	0.00	0.00	0.00	0.00	0.00	0.00
Hardness on Moh's scale		9.00	7.50	7.50	8.50	8.0	5.5
Hardness on Vicker's Scale	Hv _{0.05}	1100-1150	690	650	962	1080	500-550
Avg. Bead size taken for crushing strength	mm	Ø 1.50	Ø 1.49	Ø 1.51	Ø 1.50	Ø 1.40	Ø 1.66
Crushing Load	Kgf	72.50	47.30	51.00	70.22	58.21	45.00
Sphericity for 90% of the beads	--	> 0.95	> 0.9	> 0.9	> 0.9	> 0.9	0.95
% Cumulative Weight Loss Per Hour of Wear Test (Wear Test conducted with Water at 3000 RPM)	After 24 Hrs.	0.0063	0.0255	0.032	0.0191	0.0206	0.2724
	After 96 Hrs.	0.00582	0.041	0.056	0.034	0.0128	0.2982
Surface Condition of Beads observed after 96 Hrs. of Wear Test in water	--	Glossy Satin smooth surface, free from Pinholes & no broken beads	Glossy Satin smooth surface, few beads with Pinholes & broken beads observed	Glossy Satin smooth surface with Pinholes & bead fused with other bead observed	Dull surface finish beads with Pinholes observed	Glossy Satin smooth surface finish observed	Dull surface finish observed

GRAPHICAL REPRESENTATION
OF WEAR TEST RESULTS



MEDIA TYPE	% CUMULATIVE WEIGHT LOSS / HR	
	AFTER 24 HRS.	AFTER 96 HRS.
Zirconium Silicate Zircosil Beads (Jyoti)	0.0063	0.00582
Zirconium Silicate Beads (France)	0.0255	0.041
Zirconium Silicate Beads (China)	0.032	0.056
Zirconium Silicate Beads (Israel)	0.0191	0.034
Zirconium Silicate Beads (Germany)	0.02059	0.0128
Glass Beads (China)	0.2724	0.2982

QUALITY ASSURANCE & CUSTOMER CARE



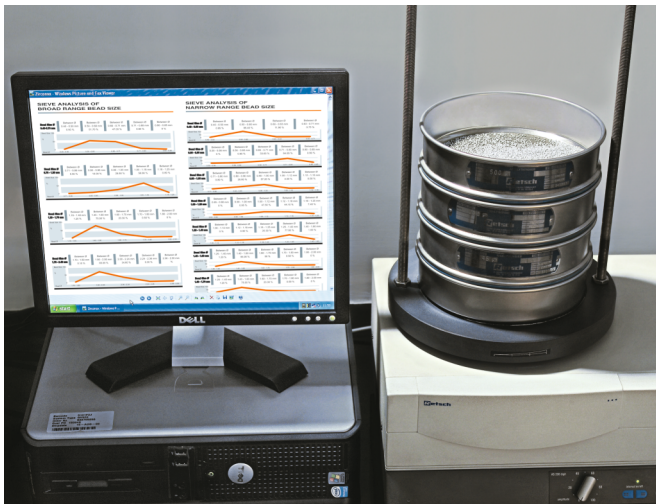
Laser Sphericity Measuring Instrument



Bead Crushing, Strength Testing Instrument

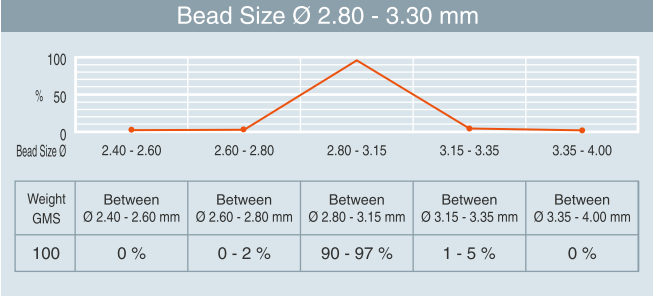
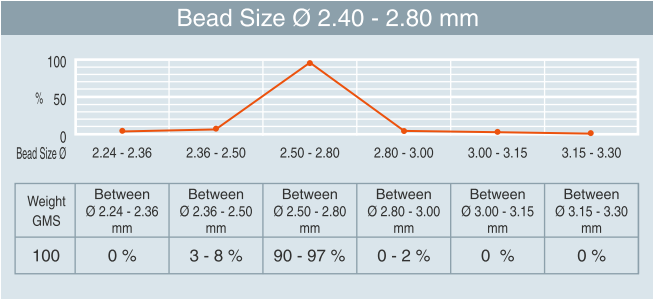
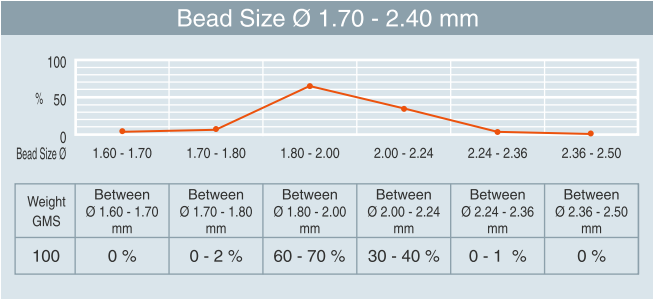
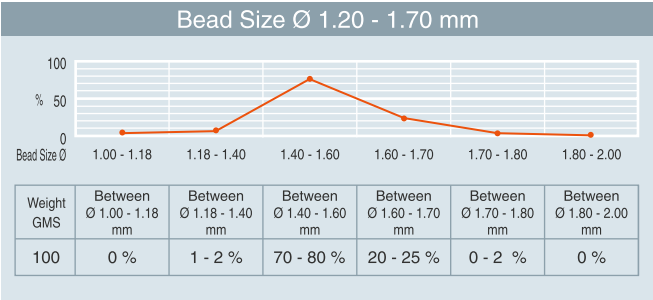
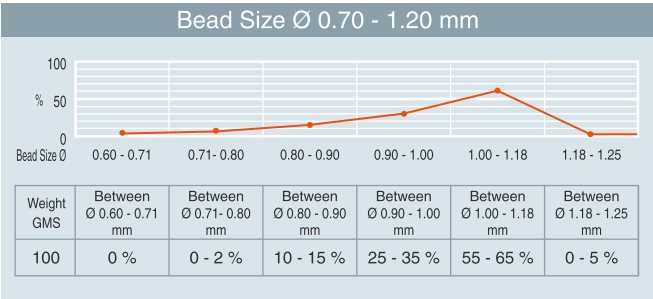
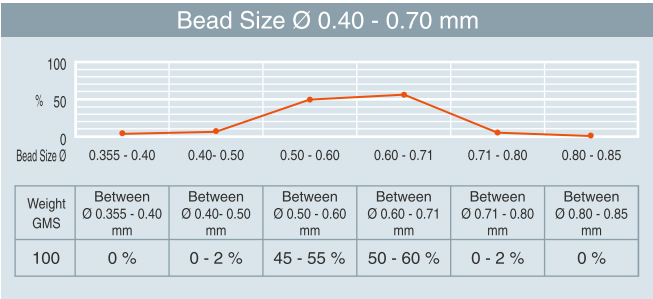


Mode of Packing

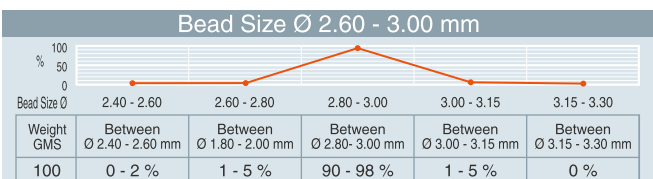
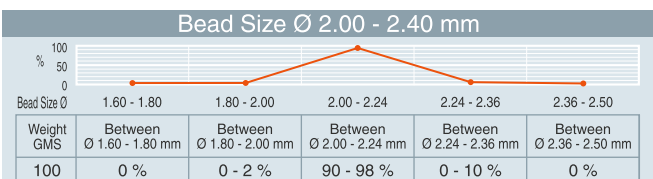
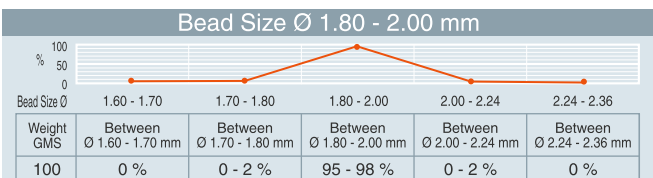
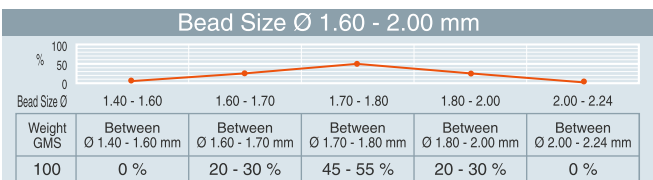
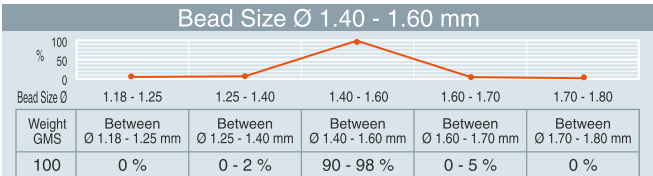
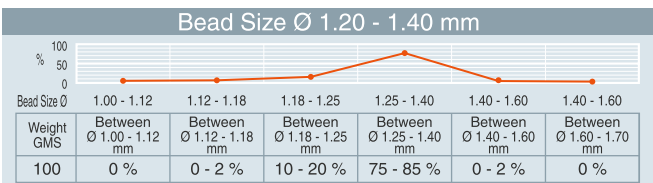
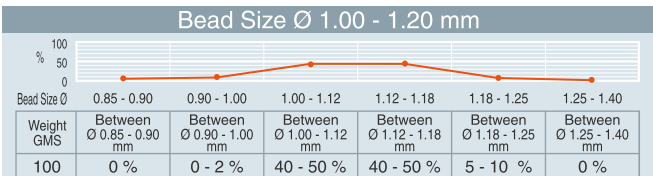
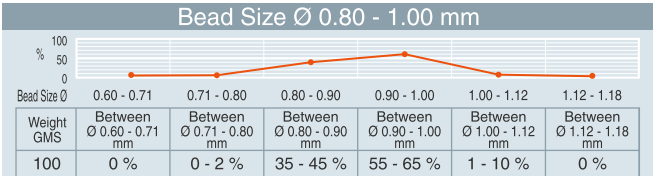
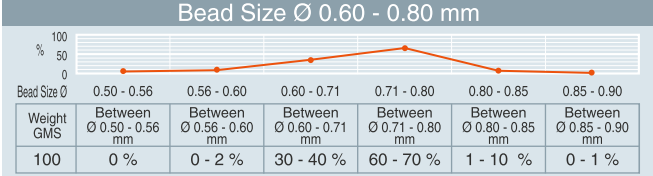
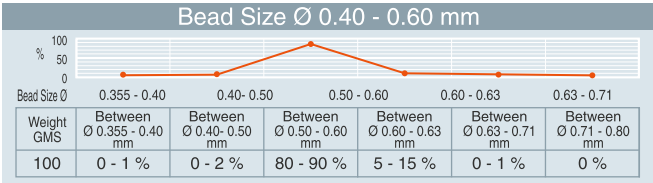


Bead Sieve Analyser

SIEVE ANALYSIS OF
BROAD RANGE BEAD SIZE



SIEVE ANALYSIS OF
NARROW RANGE BEAD SIZE





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