



glaston



About glass standards

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General

- Standards specify the characteristics that glass must fulfil when used in certain applications
 - Standards developing organizations do not regulate where to use standards
 - Other normative regulations (national or harmonized building codes, EU directives, etc.) specify which standards are to be used
 - Standards developing organizations have copyrights to the standards
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- CEN - European Committee for Standardization
 - ANSI - American National Standards Institute
 - ASTM International – A global organization, open memberships
 - ISO – International Organization for Standardization, members are various national standards organizations

Main criteria in glass standards

- Test methods and criteria for
 - Glass flatness or shape accuracy
 - Breakage behaviour
 - Mechanical strength
 - Surface stress
 - Optical distortion
 - Etc.

Architectural glass standards

ANSI Z97.1	U.S.A.	Safety glazing materials
ASTM C 1048	International	Heat treated flat glass
ASTM C 1464	International	Bent glass
ASTM C 1651	International	Measurement of roll wave optical distortion
ASTM C 1036	International	Specification for flat glass
EN 12150-1	Europe/CEN	Thermally toughened safety glass
EN 1863-1	Europe/CEN	Heat strengthened glass
EN 14179-1	Europe/CEN	Heat soaked thermally toughened safety glass
EN 12600	Europe/CEN	Pendulum test
EN 14428	Europe/CEN	Shower cabinets

Architectural glass standards

EN 14449	Europe/CEN	Laminated glass
GB 15763.2	China	Tempered glass
GB/T 17841	China	Heat strengthened glass
JIS R 3206	Japan	Tempered glass
JIS R 3222	Japan	Heat strengthened glass
AS/NZS 2208	Australia, New Zealand	Safety glazing materials
GOST R 54162	Russia	Tempered glass
GOST R 54180	Russia	Heat strengthened glass
ISO 12543	International	Laminated glass

Automotive glazing standards

ECE R43	United Nations	Safety glazing materials
ANSI Z26.1	U.S.A.	Safety glazing materials...on land highways
JIS R3211	Japan	Safety glazing materials for road vehicles
AS/NZS 2080	Australia, New Zealand	Safety glazing for land vehicles

Glass deformation definitions

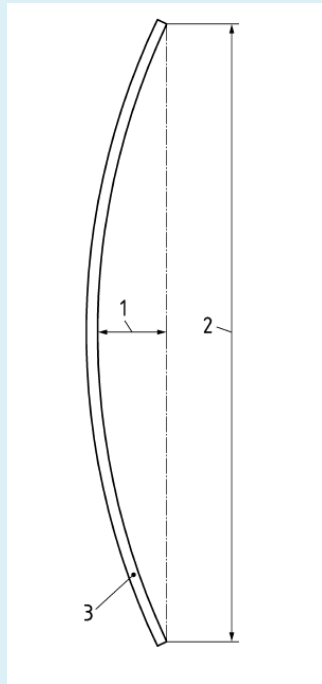
Flat glass

- Deviation from flatness
 - Overall bow
 - Roller wave
 - Wave
 - Edge lift
 - Perimeter deformation
 - Roll wave distortion in mdpt

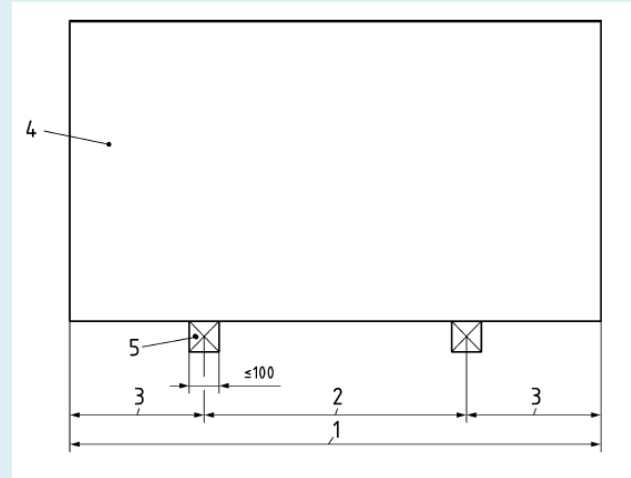
Bent glass

- Dimensional tolerances
 - Shape
 - Crossbend
 - Twist

Overall bow (EN 12150-1:2015)



1 deformation for calculating overall bow
 2 width, height or diagonal
 3



Glass is in a vertical position and supported on its longer side by two load bearing blocks at the quarter points.

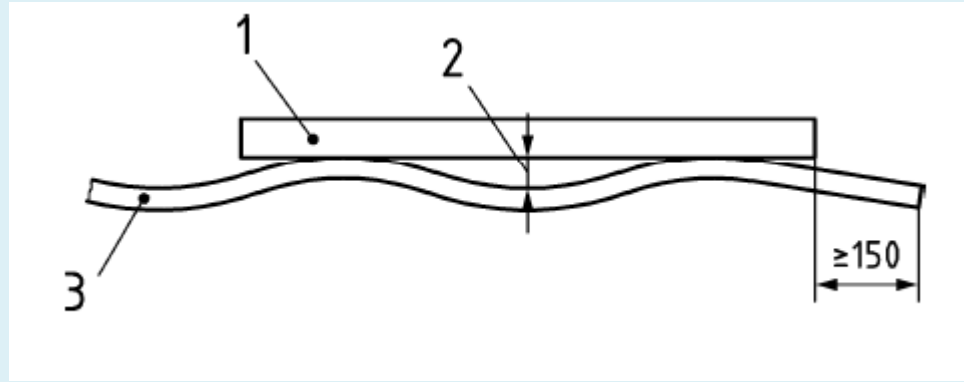
*For glass thinner than 4 mm nominal thickness the support will have an angle between 3 and 7° from the vertical.

(*This is new)

Overall bow

- Glass is placed in a vertical position and supported on its longer side by two load bearing blocks at the quarter points
- The deformation is measured along the edges of the glass and along the diagonals as maximum distance between straight metal ruler or a stretched wire and the concave surface of the glass
- The value of the bow is expressed as the deformation [mm] divided by the length of the edge of the glass or diagonal

Roller wave (EN 12150-1:2016, EN 1863-1:2011)



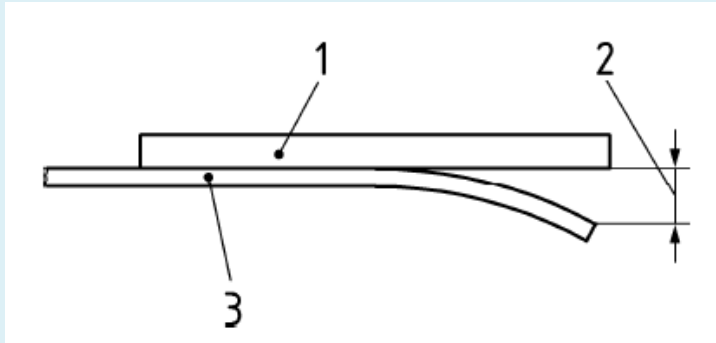
2: roller wave

1: straight edge 300 – 400 mm

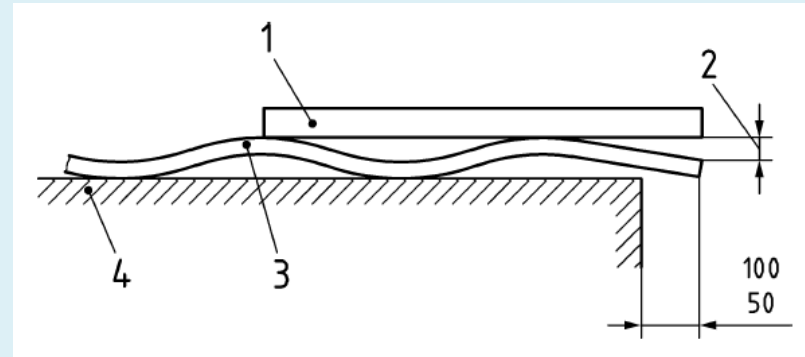
Glass pane is laid on a flat support.

Straight edge is not used closer than 150 mm from the edges.

Edge lift (EN 12150-1:2015, EN 1863-1:2011)

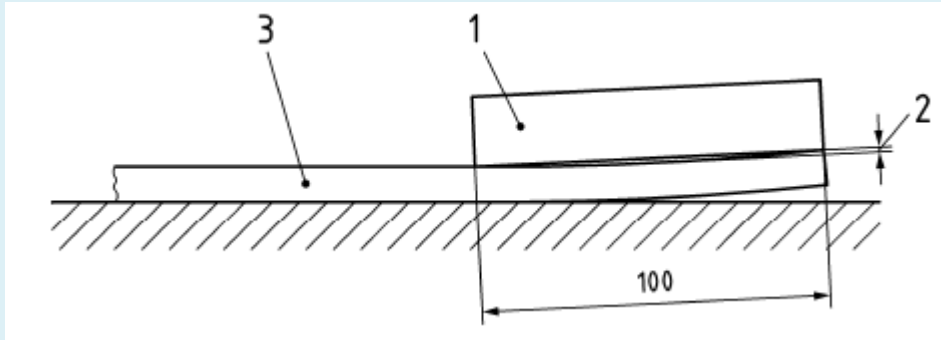


2: edge lift
1: straight edge 300 – 400 mm



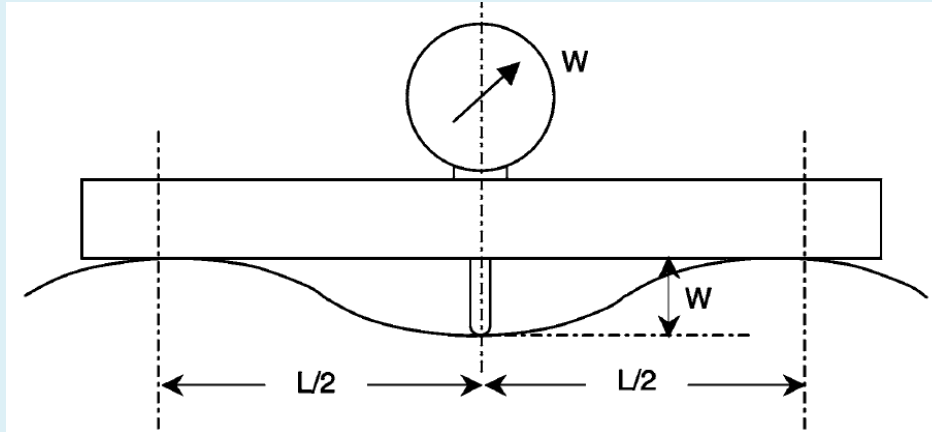
The glass is placed on a flat support with the edge lift overhanging the edge of the support by between 50 mm and 100 mm

Perimeter deformation (air cushion process, EN 12150-1:2015)



- 2: perimeter deformation
- 1: straight edge 100 mm

Roll wave distortion (ASTM C 1651)



Distortion in millidiopters, mdpt
 W and L in mm

$$D = \frac{4\pi^2 W}{L^2 10^{-6}}$$

Millidiopters with various wavelengths and valley depths



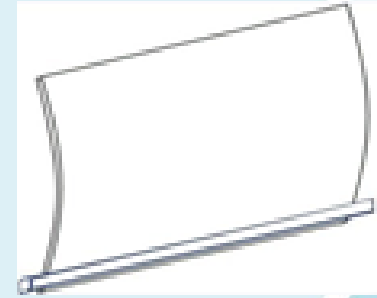
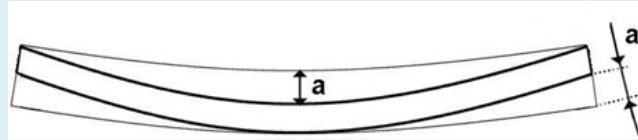
Peak-to-Valley Depth, W		Wavelength, L																												
(in)	(mm)	5,0	5,3	5,5	5,8	6,0	6,3	6,5	6,8	7,0	7,3	7,5	7,8	8,0	8,3	8,5	8,8	9,0	9,3	9,5	9,8	10,0	10,3	10,5	10,8	11,0	11,3	11,5	11,8	
0,0005	0,01	127	133	140	146	152	159	165	171	178	184	191	197	203	210	216	222	229	235	241	248	254	260	267	273	279	286	292	298	
	0,01	31	28	26	24	22	20	18	17	16	15	14	13	12	11	11	10	10	9	9	8	8	7	7	7	6	6	6		
	0,001	0,03	62	56	51	47	43	40	37	34	32	30	28	26	24	23	22	20	19	18	17	16	16	15	14	13	13	12	12	11
	0,0015	0,04	93	85	77	71	65	60	55	51	48	44	41	39	36	34	32	30	29	27	26	25	23	22	21	20	19	18	18	17
	0,002	0,05	124	113	103	94	86	80	74	68	63	59	55	52	49	46	43	41	38	36	34	33	31	30	28	27	26	25	24	23
	0,0025	0,06	155	141	128	118	108	99	92	85	79	74	69	65	61	57	54	51	48	45	43	41	39	37	35	34	32	31	29	28
	0,003	0,08	187	169	154	141	130	119	110	102	95	89	83	78	73	69	65	61	58	54	52	49	47	44	42	40	39	37	35	34
	0,0035	0,09	218	197	180	165	151	139	129	119	111	103	97	91	85	80	75	71	67	64	60	57	54	52	49	47	45	43	41	39
	0,004	0,10	249	226	206	188	173	159	147	136	127	118	111	104	97	91	86	81	77	73	69	65	62	59	56	54	51	49	47	45
	0,0045	0,11	280	254	231	212	194	179	166	154	143	133	124	116	109	103	97	91	86	82	77	74	70	67	63	61	58	55	53	51
	0,005	0,13	311	282	257	235	216	199	184	171	159	148	138	129	121	114	108	102	96	91	86	82	78	74	70	67	64	61	59	56
	0,0055	0,14	342	310	283	259	237	219	202	188	174	163	152	142	134	126	118	112	106	100	95	90	85	81	78	74	71	68	65	62
	0,006	0,15	373	338	308	282	259	239	221	205	190	177	166	155	146	137	129	122	115	109	103	98	93	89	85	81	77	74	71	68
	0,0065	0,17	404	367	334	306	281	259	239	222	206	192	180	168	158	148	140	132	125	118	112	106	101	96	92	87	83	80	76	73
	0,007	0,18	435	395	360	329	302	279	258	239	222	207	193	181	170	160	151	142	134	127	121	114	109	104	99	94	90	86	82	79
	0,0075	0,19	466	423	385	353	324	298	276	256	238	222	207	194	182	171	161	152	144	136	129	123	117	111	106	101	96	92	88	84
	0,008	0,20	497	451	411	376	345	318	294	273	254	237	221	207	194	183	172	162	154	145	138	131	124	118	113	108	103	98	94	90
	0,0085	0,22	528	479	437	400	367	338	313	290	270	251	235	220	206	194	183	173	163	154	146	139	132	126	120	114	109	104	100	96
	0,009	0,23	560	508	462	423	389	358	331	307	285	266	249	233	219	206	194	183	173	163	155	147	140	133	127	121	116	111	106	101
	0,0095	0,24	591	536	488	447	410	378	349	324	301	281	262	246	231	217	204	193	182	173	164	155	148	141	134	128	122	117	112	107
	0,010	0,25	622	564	514	470	432	398	368	341	317	296	276	259	243	228	215	203	192	182	172	163	155	148	141	134	128	123	118	113

Flatness, tempered float glass

	EN 12150-1:2015	GB 15763.2	GOST R 54162
Overall bow mm/m, ‰	3,0	3,0	3-5 mm: 3,0 6-25 mm: 2,0
Local bow / 300 mm	-	0,2% = 0,6 mm	3-5 mm: 0,5 mm 6-25 mm: 0,4 mm
Roller wave	0,3 mm	-	-
Edge lift	3 mm: 0,5 mm 4 -5 mm: 0,4 mm 6 - 25 mm: 0,3 mm	-	-
Wave	0,3 mm	-	-
Perimeter deformation / 100 mm	2 - 12 mm: 0,3 mm	-	-

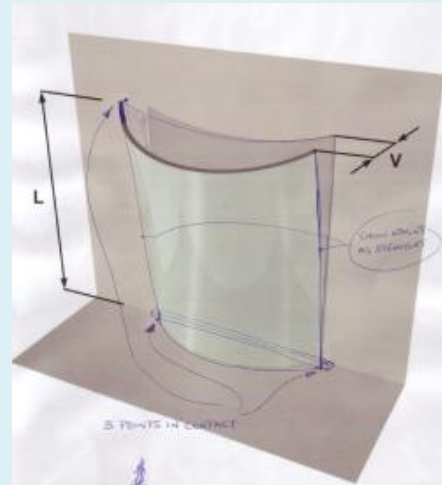
Cylindrical bent glass tolerances

Shape tolerance



Crossbend
Deviation from a straightedge along
a line perpendicular to the curvature

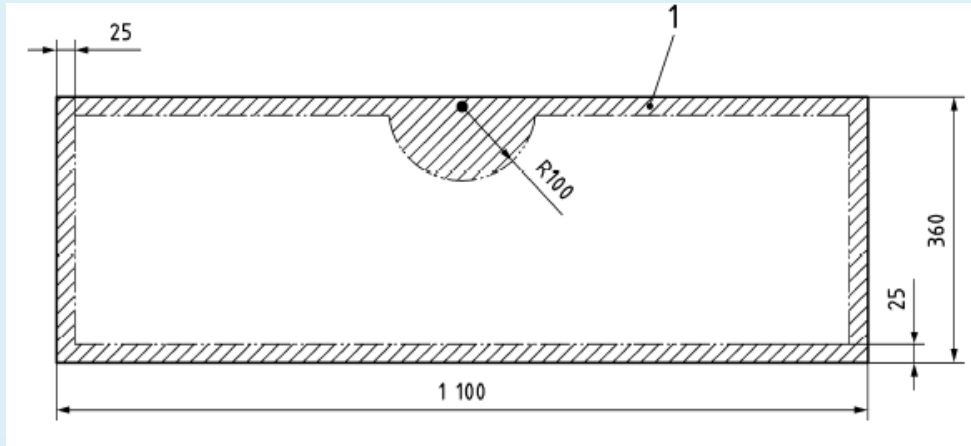
Twist
All corners are not in the same plane



Fragmentation test

(EN 12150-1, GOST R 54162)

- Test specimen 360 mm x 1100 mm
- Impacted at 13 mm in from the long edge at the mid-point of that edge
- An area of radius 100 mm, centered on the impact point, and a border of 25 mm, are excluded from the particle count



Fragmentation test

- The particle count and measuring of the dimensions of the largest particle should be done between 4 to 5 min after fracture
- The particle count is made by placing a mask of 50 x 50 mm on the test piece
- Particle count is made in the region of the coarsest fracture
- Only crack-free particles should be counted
- Particles which are partially within the mask should be counted as $\frac{1}{2}$ particle



Particle count, minimum amount in 50mm x 50mm area, tempered float glass

	EN 12150-1:2015	GB 15763.2	GOST R 54162	EN 14428
2 mm	15	-		
3 mm	15	30	15	40
4 - 12 mm	40	40	40	40
15 - 19	30	30	30	
25	30	30	30	

Other tests

Test	GB 15763.2	GOST R 54162
Impact resistance		
Test piece	610 x 610	1100 x 900
Steel ball	1040 g	227 g
Drop height	1 m	2 m, 2,5 m, 3 m
Shot bag pendulum		
Test piece	864 x 1930	1100 x 900
Pendulum bag	45 kg	45 kg
Surface stress	≥ 90 MPa	

ANSI Z97.1

- Test glass size 863 mm x 1930 mm
- Pendulum test
 - Impactor: leather bag filled with lead shots, weight 45,4 kg
 - 3 classes according to the drop height
 - Glass either does not break or if it breaks
 - Total weight of 10 largest pieces shall weigh no more than than the equivalent weight of 10 square inches (6452 mm²) of the original sample glass
- Center punch fragmentation test
 - Break point: 25 mm inboard of the long edge at its midpoint
 - Total weight of 10 largest pieces shall weigh no more than than the equivalent weight of 10 square inches (6452 mm²) of the original sample glass

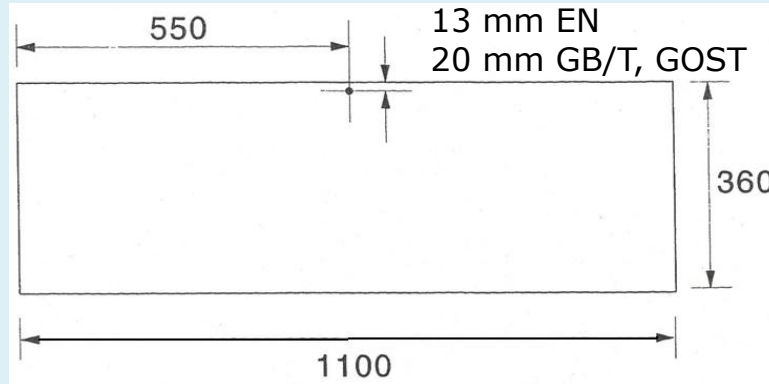
Heat strengthened glass Requirements

	EN 1863-1	GOST R 54180	ASTM C 1048	JIS R 3222	GB/T 17841
Fracture pattern	As specified	As specified	-	-	As specified
Bending strength	≥ 70 MPa	≥ 70 MPa	-	-	≥ 70 MPa
Surface compression	-	-	24...52 MPa	20...60 MPa	24...60 MPa
Pendulum test	-	As specified	-	-	-
Glass thickness	3...12 mm	3...8 mm	≤ 6 mm	6...12 mm	3...12 mm

EN 1863-1

(similar GB/T 17841, GOST R 54180)

- Dimensions of the test specimen are 360 mm x 1100 mm, without holes, notched or cut-outs
- Test specimen is laid flat on a table held so that the fragments remain interlocked
- Each specimen is impacted using a pointed steel tool at the mid-point of the longest edge



EN 1863-1 Assessment of fragmentation

(similar GB/T 17841, GOST R 54180)

- Each fragment produced shall be assessed as follows
 - At least one edge of the fragment shall reach the excluded area (sufficient as such alone)
 - If the fragment doesn't reach the excluded area either an island ($>100 \text{ mm}^2$) or a particle ($<100 \text{ mm}^2$) is produced
 - The number of island fragments shall be counted and weighed
 - Particles shall be collected and weighed

EN 1863-1 Assessment of fragmentation

(similar GB/T 17841, GOST R 54180)

- The specimen is classified as HS glass if:
 - At least four out of five specimens shall not have
 - more than 2 "island" fragments
 - any "island" fragments with area/mass equivalent exceeding 1000 mm²
 - the area/mass equivalent of all "particles" exceeding 5000 mm²
 - If only one specimen fails to meet the requirements it should meet the following requirements in order to be accepted as HS glass
 - It shall not have more than 3 "islands"
 - The area/mass equivalent of all islands and particles shall not exceed 50000 mm²