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PROPERTY OF CELLULAR SILICONE FROM HIGH-VINYL SILICONE GUMS AS A FUNCTION OF POROSITY (REFERENCED TO SE54 GUM)

ABSTRACT

We have established the load-deflection properties of cushions from the high methylvinylsiloxane (MVS) content gums, L97KVB-0.7, MN97KVB-0.7, and L60VB-0.7, as a function of cushion porosity. These properties are referenced to the properties of cushions from General Electric's (GE) SE54 gum which has considerably less MVS. The higher MVS gums produce considerably stiffer cushions. We have also evaluated the confined compression set of these various porosity cushions. There is no pattern for set as a function of porosity. Set is reduced at the higher MVS contents.

We have established the densities of the cured solid elastomers (3219) from the four silicone gums. We have also calculated a linear relationship between porosity of the cushions and the wt% of urea temporary filler in the molding compound for the 97-type gums and L60 gum.

L97KVB-0.7 and MN97KVB gums produce cushions with similar but not exactly the same load-deflections and sets, and are alike in their correlations of porosity with urea loading. L60VB-0.7 produces a softer cushion and probably has less set than the 97-type gums at 0.7% MVS.

INTRODUCTION

Lawrence Livermore National Laboratory (LLNL) has used cellular silicones as support materials and space fillers in weapons for roughly 20 years. Recently, our sole commercial vendor stopped supplying both the silicone gum and the filled molding compounds. We have established our own technology to both synthesize silicone gums and compound them to cellular silicones. We are in the process of developing replacement gums and cellular silicones equal to or superior to those we had.

The silicone gums we have evaluated include GE's low-vinyl SE54 gum, our L97KVB gum, which we hope is an improved version of the original commercial product, and our L60VB block copolymer gum, which is better than L97KVB. We are also evaluating commercial sources of L97KVB gum, mainly McGhan-NuSil Corporation. We originally selected a nominal methylvinylsiloxane (MVS) content of 0.7 wt% for our experimental gums based on an earlier study of the effect of vinyl content on the load properties and compression set of cellular silicone.[1] At present, our interest has shifted to a nominal 0.4 wt% MVS in order to produce a softer cushion. The other major way to vary cushion stiffness (load-deflection properties) is to vary the porosity of the cellular silicone.

We varied the porosity of L97KVB-0.7, MN97KVB-0.7, and L60VB-0.7 over the range of 45 to 70% porosity, and measured load-deflection properties and confined compression set. We include limited data for SE54 gum for comparative purposes. Full experimental data on set and load-deflection for all cushions from all gums discussed in this report are tabulated in Tables A1 through A18 in Appendix A.

EXPERIMENTAL

MATERIALS

We used one lot each of the experimental gums and one lot of SE54 in our porosity study. The SE54 gum was purchased from GE. Our L97KVB was synthesized in-house to be a random equilibration terpolymer of dimethyl, diphenyl, and methylvinylsiloxane containing 0.7 wt% MVS and 9 wt% DPS. The MN97KVB gum was synthesized in a 200-lb batch by McGhan-NuSil, with our guidance, to duplicate L97KVB.[2] The L60VB gum was synthesized in-house to be an alternating-block condensation terpolymer of DMS, DPS, and MVS with the same MVS and DPS contents as L97KVB.[3,4] All three experimental polymers were vinyl end-blocked. Data for the polymer lots are shown in Table 1.

To prepare 1668, we added 32 parts by weight of CaboSil Grade MS7 SiO_2, 6 parts by weight of Hi Sil 233 Grade SiO_2 and 10 parts by weight of Y1587 processing aid to 100 parts by weight of silicone gum for L97KVB, MN97KVB, and L60VB. For SE54, we used 11 parts of Y1587. Only one lot of each ingredient was used and the lots were purchased commercially.

To cure 3219, we activated the 3219s with Esperox 497XL which is tertiary butyl per-2-methylbenzoate. We added 0.56 parts by weight of 497XL to the

3219s from SE54 gum and 2 parts by weight of 497XL to the 3219s from L97KVB, MN97KVB, and L60VB gums.

To prepare molding compounds, we activated the 3219s with 497XL as we did for curing 3219s. We also added urea (parts by weight) per 100 parts by weight of 3219 to achieve porosities as shown in Table 2.

For all but three runs, we used Sherritt-Gordon Mines urea supplied to us by Bendix. For three runs, we used Dupont urea from our own stock. Both ureas were screened to -25 to +40 mesh, U.S. Sieve Nos. Urea source is not a significant variable in the preparation of cellular silicone.

COMPOUNDING

For preparing L1668s, we established a standard addition sequence for the gum: MS7, HiSil 233, and Y1587. This sequence was used in all cases. Most mixings were done in our 1-lb size Banbury intensive mixer but the more recent mixes were made in our new Haake intensive mixer. A large batch of MN97KVB-0.7 B1668 was prepared by Bendix Kansas City (BKC) on their production scale intensive mixer. Compositions and mixer types are listed in Table 3. The type of mixer used to prepare L1168 is not considered a significant variable in the production of cellular silicone. Final blending and sheeting of all L1668s were done on our EEMCO 2-roll rubber mill. B1668 was blended on the Bendix production rubber mill. All of the approximately 6-mm thick sheets of 1668 were bin-aged at ambient conditions for at least 28 days. Aged 1668s were heat-stripped in an air-circulating oven at 171° to 177°C for 18 h to produce L3219 or LB3219 base gums. The B1668 was also heat stripped by BKC to produce BB3219 (TJ1208811). We added 497XL curing agent to 3219 base gums on our rubber mill and molded the activated 3219s to about 2-mm sheets in a flat-slab steel mold. Curing agent amounts and cure cycles are shown in Table 4. All cured sheets of 3219 were post cured unconfined for 16 h at 249°C in an air-circulating oven.

The various molding compounds were prepared by our standard technique. Curing agent was added to 3219 on the 2-roll mill. Temporary filler was added to activated 3219 either in the Banbury mixer or in the Haake mixer. Final mixing and sheeting of the molding compounds were carried out on the 2-roll mill.

Molding compounds were converted to cellular silicone in a series of steps. Flat sheets of a normal 2.6 mm thickness and 200 by 200 mm square were molded in a flat-slab steel mold at an appropriate time and temperature in a Pasadena Hydraulics press. The press cured sheets of molding compound were washed in about 90°C water in a washing machine by our standard washing sequence. The washed cushions were dried at ambient temperatures for 16 h and then oven-dried at 149°C for 4 h. Dried cushions were post-cured for 24 h at 149°C. All cushions are identified in Table 5.

TESTING

We measured the density of all 3219s by an immersion technique. The density of 3219 is required to calculate the porosity of the cellular silicone from the following equation:

$$\% \text{ porosity} = \left(1 - \frac{\text{cushion density}}{\text{3219 density}}\right) 100 \quad . \tag{1}$$

These measured 3219 densities are listed in Table 4. We measured the swell ratio (V/V_0) of 3219s by soaking them for eight days in chlorobenzene to reach equilibrium. Results are shown in Table 4.

Cushion densities were measured on both load-deflection disks (6.46 mm^2 area) and confined compression set disks (317 mm^2 area). Samples were weighed and measured between slide glasses with a micrometer for thickness but the diameter was assumed to be a constant; disk densities were calculated.

Cushions were tested for load-deflection properties at room temperature on an Instron test machine with a crosshead speed of 1.25 mm/min. Test results for all cushions are listed in Appendix A. Disks were compressed to different degrees for different porosities as shown in Table 6.

Compression sets were run on the larger disks by our confined-die test. Disks were compressed to different degrees for different porosities as shown in Table 6. Groups of five compressed samples were placed in an air-circulating oven at 149°C for 24 h. After cooling to room temperature under compression, the disks were removed from the dies and their free heights were measured as a function of time at room temperature. Percent recoveries of original thicknesses were calculated. Set was calculated at 1-h recovery as follows:

$$\% \text{ compression set} = \left(\frac{100 - \% \text{ recovery at 1 h}}{\% \text{ compression}}\right) 100 \quad . \tag{2}$$

RESULTS

3219 DENSITIES AND SWELL RATIOS

The measurement of most importance to this report is the elastomer density of cured 3219s. We assume that the density of the solid elastomer (3219) is the same as the density of the solid silicone in the cellular silicone. We presume that the presence of urea during cure and the difference in length of post-cure of cellular silicone have no significant effect on the density of the solid silicone. Swell ratios are included only to better understand the L3219 densities.

Densities and V/V_0 of 3219s for individual batches of each gum or pressing of 3219 are listed in Table 4. Densities and V/V_0 of 3219 are averaged for each batch of 3219 from each gum and for each gum in Table 7. Density and V/V_0 reproducibility are very good except for TJ115-3E. L97KVB-0.7 and MN97KVB-0.7 have the same 3219 density which is higher than both SE54 and L60VB-0.7. L97, MN97, and L60 L3219s have the same V/V_0. We would expect a higher vinyl content gum, which is fully activated, to be more highly crosslinked (lower V/V_0) and have a higher density; therefore, L60VB's density is an anomaly. The molecular structure of L60VB is intentionally quite different from SE54, L97KVB, and MN97KVB, which are probably very similar. The block copolymer structure of L60VB probably produces bulkier molecules which compact less even at the higher degree of crosslinking. For cushion porosity, the experimental density of the specific lot of 3219 is used for the calculation.

CUSHIONS FROM SE54 SILICONE GUM

SE54 gum is included in this report only for comparison. Densities of the load-deflection disks and set disks and the porosities calculated from them are shown in Table 8. Densities of the two different size disks agree well, as do the calculated porosities. Sheet-to-sheet variation is small, with a % coefficient of variation (% C of V) = 0.7 for porosity for L3260 and about twice that for L3223. The load-deflection and set properties of the two cushions are listed in Table 9 and the load-deflection curves are plotted in Fig. 1. With all the known minor variables included in this data, the % C of V averages about 9% over the load range for the two cushions. Compression set is much more variable with an average % C of V of about 35% and set is the same for both cushions. The low vinyl content of SE54 and the temperature limitations of 125°C to prevent urea melting may make it difficult to crosslink SE54 to the maximum and obtain good reproducibility. The high results for TJ115-3EBU L3260 are suspicious, but we have no explanation. The set for TJ115-3EBU L3223 appears normal. In Fig. 2, the loads for SE54 cushions at various deflections as a function of porosity are plotted. For SE54, Fig. 2 is only a 2-point curve; this curve has been more fully developed for the new, higher-vinyl gums.

CUSHIONS FROM 97KVB TYPE SILICONE GUMS

L97KVB-0.7

Our L97 gum was evaluated over the porosity range of 45 to about 70%. Densities and calculated porosities are listed in Table 10. Density agreement between disk sizes and among batches is good with coefficients of variations of 1% or less. The load-deflection and set properties of the series of cushions are shown in Table 11; the load-deflection curves are plotted in Fig. 3. Batch-to-batch reproducibility of load deflection is much better for L3260 than for L3223, but the reverse is true for compression set. The loads for the cushions at various deflections as a function of porosity are plotted in Fig. 4. The values for L3260 do not fit the smooth curves resulting from the other porosities. It appears that the porosity of L3260 is about 2% too high. Compression set as a function of porosity is shown in Fig. 5. There is no pattern for set as a function of porosity in L97KB-0.7.

MN97KVB-0.7

The commercial equivalent of our L97 gum was evaluated over the same porosity range as L97. Densities and calculated porosities are shown in Table 12. Density agreement is even better for L97KVB-0.7. The load-deflection and set properties of the series of cushions are tabulated in Table 13. The load-deflection curves are plotted in Fig. 6. The L-cushions were prepared by us from our own L1668 and L3219 materials. We prepared the

LB-cushions from our LB3219 made from B1668, prepared originally by Bendix. We prepared the LBB-cushions from Bendix-made B1668 and BB3219. There are differences among these cushions which indicate that we and Bendix do not process exactly in the same manner, but these processing differences are probably not significant. The loads for the cushions at various deflections as a function of porosity are plotted in Fig. 7. As for L97, it appears that the porosity of L3260 and also one sample of L9755 are slightly high. Compression set of MN97KVB-0.7 as a function of porosity is plotted in Fig. 5. Like L97, there seems to be no trend to a decrease in set as porosity increases in MN97KVB-0.7. Also MN97 probably has the same set as L97. The load-deflection curves of L97 and MN97 at three different but equal porosities are derived from Figs. 4 and 7 and plotted in Fig. 8. MN97KVB-0.7 silicone gum consistently produces a softer cushion than does L97KVB-0.7 gum.

CUSHIONS FROM L60VB-0.7 GUM

Our L60 gum was evaluated over the same porosity range as the 97-type gums, namely 45 to 70%, except for set data. Densities and calculated porosities are listed in Table 14. Density agreement is very good except for L3260. Load-deflections and set properties are tabulated in Table 15. Load deflections are plotted in Fig. 9. The cushion loads at various deflections as a function of porosity are shown in Fig. 10. All data are reasonably consistent. The compression set of L60VB-0.7 as a function of porosity is shown in Fig. 5. We did not measure the set of L6055 and L6070 because we inadvertently cut the sample disks too small and decided not to repeat the runs. There is no pattern to the set of L60 as a function of porosity. The load deflections of L60 are compared to those of L97 and MN97 in Fig. 8. L60 produces slightly softer cushions than L97 or MN97 and the differences are more apparent at the higher deflections.

CORRELATION OF UREA-LOADING WITH CUSHIONS DENSITY AND POROSITY

The current philosophy is to designate cushions by % porosity instead of density. This has led to a change in nomenclature; for example, L3223 and L3260 were defined by density ranges. These changed to L9745 (old L3223) and L6060 which are now defined by porosity ranges. For development purposes, L denotes that LLNL made the cushion; in the first two digits, 97 or 60 denotes the gum type, while in the last two digits, 45 or 60 denotes nominal porosity. We measured cushion density and calculated cushion porosity from the cushion density and the cured density of the L3219 used to prepare the molding compound.

For L60VB-0.7 we have calculated porosities for the various urea loadings. The experimental data are shown in Table 16 and are plotted against parts of urea per hundred parts of L3219 plus two parts of 497XL crosslinking agent in Fig. 11. We have also calculated a theoretical density and porosity based on the weights of urea, L3219 and 497XL, and the density of cured L3219 of 1.178 Mg/m^3 and a density for urea of 1.34 Mg/m^3 used by Bendix in their calculations; these results are also shown. Theoretical density is consistently lower and porosity higher than experimental values. This is probably due to weight loss of low molecular weight gum components and curing agent fragments during washing and post-cure.

We also calculated the porosities at various urea loadings for both L97KVB-0.7 and MN97KVB-0.7. The data for both gums are shown in Table 17 and plotted in Fig. 12. L97 and MN97 are considered to be alike.

From the curves of Figs. 11 and 12, we constructed Table 18 which shows the parts of urea required to achieve specific porosities for 97KVB-0.7 and 60VB-0.7-type gums and the densities that result. We converted parts of urea to wt% urea in the molding compound as shown in Tables 16 and 17. We plotted cushion porosity vs wt% urea in the molding compound in Fig. 13. The correlation is linear for both 97- and 60-type gums so we computed the following equations by linear regression analysis. Using Eq. (1) for L97KVB-0.7 and MN97KVB-0.7, we find a % porosity = 1.0174 wt% urea - 6.4491 and a correlation coefficient = 0.9989. Using Eq. (2) for L60VB-0.7, we find a % porosity = 1.0447 wt% urea - 7.8424, and a correlation coefficient = 0.9977.

The curves shown in Fig. 13 are the two equations. From the equations, we calculated the wt% urea and converted them to parts per hundred parts of L3219 plus two parts of 497XL by weight in the molding compound. These values are also listed in Table 18.

CONCLUSIONS

All four gums evaluated show the expected decrease in load-bearing capacity with increasing porosity. The three 0.7% MVS gums, which are more highly crosslinked than SE54 gum (~0.3% MVS), produce much stiffer cushions than SE54. The order of decreasing stiffness is L97KVB-0.7, MN97KVB-0.7 and L60VB-0.7.

There is no correlation of set with porosity for the L97 gums or the L60 gum. In general, L97 gum has the highest set and L60 gum the lowest. The data for these conclusions are only suggestive, not conclusive.

L97 and MN97 gums have the same cured L3219 density and the same correlation of cushion density with urea content of the molding compound. This was expected since L97 and MN97 were meant to be alike. L60 and SE54 gums have the same cured L3219 density which is lower than that for 97-type gums. This was not expected since L60 and SE54 are crosslinked to considerably different degrees (V/V_0 of 2.28 vs 3.62) and density should increase with measured crosslinking. L60 has the same high degree of crosslinking in its L3219 as the 97-type gums but has the cured L3219 density of SE54. The molecular configuration of L60 must be quite different than 97-type gums and SE54. L60 has a different correlation of cushion density with urea content of the molding compound than does 97-type gums. The equation for each has been derived.

RECOMMENDATIONS

Since our main interest has shifted to a softer cushion, such as produced by SE54 gum based on a 97-type gum, we have been trying to establish a 97-type gum with a lower MVS content of 0.4 wt%. Once we have obtained a commercial lot of such a gum, we should establish the load-deflection properties as a function of porosity and the porosity-urea loading relationship for this gum, such as we have for the gums with 0.7 wt% MVS. Also, it would be highly desirable to make a comparative evaluation of L60VB or its commercial equivalent with the 97-type gum, both at the same lower MVS content.

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GMR/jvb

GLOSSARY

Banbury Intensive Mixer:
Mixer produced by Farrel-Birmingham Co., Inc., Ansonia-Derby CT.

Bendix, BKC:
The Bendix Corporation, Kansas City Division, Kansas City, MO.

CaboSil MS7:
Specific grade of silicone dioxide made by the Cabot Corporation, Boston, MA.

Δt:
Difference in starting thickness between the first and third cycles of the load-deflection curves as measured by the Instron test machine.

DMS:
Dimethylsiloxane repeating unit in silicone polymers.

DPS:
Diphenylsiloxane repeating unit in silicone polymers.

Dupont:
E. I. duPont de Nemours and Co., Wilmington, DE.

EEMCO Rubber Mill:
Two-roll mill produced by the Erie Engine and Manufacturing Co., Erie, PA.

Esperox 497SL, 497XL:
Tertiary butyl per-2-methyl benzoate at 40% concentration on calcium carbonate. A peroxide curing agent produced by Witco Chemical Corporation, U.S. Peroxygen Division, Richmond, CA.

GE:
General Electric, Silicone Products Department, Waterford, NY.

GPC:
Gel permeation chromatography.

Haake Mixer:
One pound intensive mixer, System 80, produced by Haake, Inc., Saddle Brook, NJ.

HiSil 233:
Specific grade of silicone dioxide produced by Pittsburgh Plate Glass Industries, Inc., Pittsburgh, PA.

Instron Test Machine:
Universal test machine produced by the Distron Corp., Canton, MA.

L60VB-0.7, L60VB, L60:
Vinyl end-blocked, block polymerized silicone polymer produced by LLNL.

L6050, L6055, L6060, L6065, L6070:
Molding compound of L3219, urea, and 497XL or cellular silicone produced from the molding compound; all stages made by LLNL. Cushions based on L60VB gum with porosity varying form 50 to 70%.

L97KVB-0.7, L97KVB, L97:
Vinyl end-blocked equilibrium polymerized silicone polymer produced by LLNL.

L9755, L9760, L9765, L9770:
Molding compound of L3219, urea and 497XL or cellular silicone produced from the molding compound, all stages produced by LLNL. Cushion based on 97 type gum with porosity varying from 55 to 70%.

L1668, B1668, 1668:
Intermediate SiO_2 reinforced gum. L-produced by LLNL; B-produced by Bendix.

L3219, LB3219, B3219, 3219:
Heat stabilized 1668, L-produced by LLNL; LB-produced by LLNL from B1668; B-produced by Bendix.

L3223, LB3223, LBB3223:
Molding compound of 3219, urea, and 497XL or cellular silicone produced from the molding compound. Nominal cushion density of 0.63-0.65 Mg/m^3. L-produced by LLNL; LB-produced by LLNL from B1668; LBB-produced by LLNL from B3219.

L3260:
Like L3223 but with a nominal density of 0.52 to 0.55 Mg/m^3.

LB9750, LB9755, LBB9755, LB9760, LB9770:
Molding compound of 3219, urea, and 497XL or cellular silicone produced from the molding compound. Porosity range of cushions from 50 to 70%. LB-produced by LLNL from B1668; LBB-produced by LLNL from B3219.

L/D Disks:
29 mm diameter disks cut from cushion sheets for load-deflection testing.

LLNL:
Lawrence Livermore National Laboratory, Livermore, CA.

McGhan NuSil:
McGhan NuSil Corporation, Carpinteria, CA.

M_n:
Number-average molecular weight from GPC measurements based on polystyrene equivalents.

MN97KVB-0.7, MN97KVB, MN97:
Vinyl end-blocked equilibrium polymerized silicone polymer produced by McGhan NuSil.

MVS:
Methylvinylsiloxane repeating unit in silicone polymers.

M_w:
Weight-average molecular weight from GPC measurements based on polystyrene equivalents.

MWD:
Molecular weight distribution; the ratio of Mw to Mn.

n:
Number of samples or materials tested.

NMR:
Nuclear magnetic resonance.

Pasadena Hydraulic Press:
Molding press made by Pasadena Hydraulics, Inc., El Monte, CA.

% C of V:
Coefficient of variation; (s/av)100.

SE54:
Specific grade of silicone polymer produced by G.E.

Sherritt-Gordon Mines:
Sherritt-Gordon Mines, Ltd., Fort Saskatchewan, Alberta, Canada.

TJ115, etc.:
LLNL sample identification code.

V/V_0:
Ratio of the swollen polymer volume to the original polymer volume. A measure of degree of crosslinking.

Y1587:
Ethoxy-end-blocked dimethylsiloxane fluid produced by Union Carbide Corporation, Silicone Rubber, New York, NY.

Table 1. Properties of uncured silicone gums.

Molecular weight[a]	SE54 Lot 167	L97KVB TJ150	MN97KVB TJ164	L60VB TJ154
M_W	745,000	590,000	514,150	478,000
M_N	333,500	250,000	192,400	182,500
MWP	2.24	2.38	2.67	2.62
wt% MVS[b]	0.27	0.7	0.69	0.80
wt% DPS[b]	14.3	9.6	8.52	9.64

[a] By GPC, based on polystyrene equivalents.
[b] By FTNMR.

Table 2. Parts of urea per hundred parts of L3219 (by weight) to achieve various porosities of cellular silicone.

% Porosity	Cushion identity	SE54	L97KVB	MN97KVB	L60VB
~46	L3223	100	100	100	100
50	-	-	-	129	130
55	-	-	151	163	161
~58	L3260	170	170	170	170
60	-	-	185	194	197
65	-	-	234	-	241
70	-	-	285	327	325

Table 3. Compositions of and mixing equipment for 1668's.

Gum	Identification		Parts per hundred parts of 1668 by weight			
			MS7	HiSil 233	Y1587	Mixer
SE54	L1668	TJ115	32	6	11	Banbury
SE54	L1668	TJ115-2	32	6	11	Banbury
SE54	L1668	TJ115-3	32	6	11	Haake
L97KVB-0.7	L1668	TJ150	32	6	10	Banbury
L97KVB-0.7	L1668	TJ150-2	32	6	10	Banbury
L97KVB-0.7	L1668	TJ150-3	32	6	10	Haake
MN97KVB-0.7	L1668	TJ164	32	6	10	Banbury
MN97KVB-0.7		TJ175	32	6	10	Banbury
MN97KVB-0.7	B1668	TJ1209811	32	6	10	Bendix
	and	TJ1208811				
L60VB	L1668	TJ154	32	6	10	Banbury

Table 4. Densities, swell ratios, curing agent amounts, and cure cycles of 3219s.

Gum	Identification		Density (Mg/m^3)	V/V_0	Amount 497XL[a]	Cure cycle min	Cure cycle °C
SE54	L3219	TJ115E-1	1.172	3.68	0.56	60	125
		TJ115E-2	1.174	3.66	0.56	60	125
		TJ115-2E-1	1.178	3.34	0.56	100	120
		TJ115-2E-4	1.180	3.65	0.56	100	120
		TJ115-2E-7	1.178	3.30	0.56	100	120
		TJ115-2BE	1.177	3.95	0.56	100	120
		TJ115-3E	1.174	4.88	0.56	100	120
L97KVB-0.7	L3219	TJ150E	1.193	2.26	2.1	60	125
		TJ150-2E	1.193	2.34	2	60	125
		TJ150-3E-2	1.193	2.28	2	60	125
		TJ150-3E-3	1.191	2.28	2	60	125
		TJ150-3BC	1.192	2.27	2	60	125
MN97KVB-0.7	L3219	TJ164E	1.187	2.30	2	100	125
		TJ175E	1.191	2.29	2	60	125
	LB3219	TJ1209811E	1.196	2.26	2	100	125
	BB3219	TJ1208811E	1.191	2.33	2	100	125
L60VB-0.7	L3219	TJ154E	1.178	2.28	2	60	125

[a] Parts per hundred parts of 3219 by weight.

Table 5. Cushion identification.

Gum	Identification		1668 mixer	Molding compound mixer	Cure (min)	Cycle (°C)
SE54	TJ115-2EBU-1	L3260	Banbury	Banbury	100	120
	TJ115-2EBU-4	L3260	Banbury	Banbury	100	120
	TJ115-2EBU-7	L3260	Banbury	Banbury	100	120
	TJ115-2BEBU-1	L3260	Banbury	Banbury	100	120
	TJ115-2BEBU-2	L3260	Banbury	Banbury	100	120
	TJ115-2BEBU-3	L3260	Banbury	Banbury	100	120
	TJ115-2BEBU-A	L3260	Banbury	Banbury	100	120
	TJ115-3EBU-IA	L3260	Haake	Haake	100	120
	TJ115-3EBU-IIA	L3260	Haake	Haake	100	120
	TJ115-3EBU-IIIA	L3260	Haake	Haake	100	120
	TJ115-3EBU-IB	L3260	Haake	Haake	100	125
	TJ115-3EBU-IIB	L3260	Haake	Haake	100	125
	TJ115EBU	L3223	Banbury	Banbury	60	125
	TJ115EBU	L3223	Banbury	Banbury	100	120
	TJ115ELU[a]	L3223	Banbury	Banbury	60	125
	TJ115-2BEBU-A	L3223	Banbury	Banbury	100	120
	TJ115-3EBUA	L3223	Haake	Haake	100	120
L97KVB-0.7	TJ150EBU	L3223	Banbury	Banbury	60	125
	TJ150-2EBU	L3223	Banbury	Banbury	60	125
	TJ150-3-BEBU-1	L3223	Haake	Haake	60	125
	TJ150-3-BEBU-2	L3223	Haake	Haake	60	125
	TJ150EBU	L3260	Banbury	Banbury	100	125
	TJ150-2EBU	L3260	Banbury	Banbury	100	125
	TJ150-3BEBU-1	L3260	Haake	Haake	100	125
	TJ150-3BEBU-2	L3260	Haake	Haake	100	125
	TJ150-2EBU-I	L9760	Banbury	Banbury	100	125
	TJ150-2EBU-II	L9765	Banbury	Banbury	100	125
	TJ150-2EBU-III	L9770	Banbury	Banbury	100	125
	TJ150-3BEBU-2	L9755	Haake	Haake	100	125
MN97KVB-0.7	TJ164ELU[a]	L3223	Banbury	Banbury	100	125
	TJ175ELU[a]	L3260	Banbury	Banbury	100	125
	TJ1209811EBU	LB3223	BKC	Haake	100	125
	TJ1208811EBU-1	LBB3223	BKC	Haake	100	125
	TJ1209811EBU	LB9755	BKC	Haake	100	125
	TJ1208811EBU-1	LBB9755	BKC	Haake	100	125
	TJ1209811EBU-1	LB9750	BKC	Haake	100	125
	TJ1209811EBU-1	LB9760	BKC	Haake	100	125
	TJ1209811EBU-1	LB9770	BKC	Haake	100	125
L60VB-0.7	TJ154EBU	L3223	Banbury	Banbury	100	125
	TJ154EBU	L3260	Banbury	Banbury	100	125
	TJ154EBU-1	L6050	Banbury	Haake	100	125
	" Repeat -1	L6050	Banbury	Haake	100	125
	TJ154EBU-1	L6055	Banbury	Haake	100	125
	TJ154EBU-I	L6060	Banbury	Banbury	100	125
	TJ154EBU-II	L6065	Banbury	Banbury	100	125
	TJ154EBU-1	L6070	Banbury	Haake	100	125

[a] LLNL urea.

Table 6. Test conditions for varying porosity.

Porosity (%)	% Deflection for load	% Compression for set
~46 (L3223)	40	35
50	41.5	37.5
55	43	41
~58 (L3260)	45	40
60	45	45
65	50	50
70	60	60

Table 7. Comparison of the swell ratios and densities of 3219s for various gums.

Identification	V/V_0 n	V/V_0 av	V/V_0 S.D.[a]	Density (Mg/m^3) n	Density (Mg/m^3) av	Density (Mg/m^3) S.D.	% C of V
SE54							
L3219 TJ115E	2	3.67	-	2	1.173	-	-
L3219 TJ115-2E and -2BE	4	3.56	0.30	4	1.178	0.0013	0.11
L3219 TJ115-3	1	4.88	-	1	1.177	-	-
2 or 3 batches from SE54	2	3.62	-	3	1.176	0.0026	0.22
L97KVB-0.7							
L3219 TJ150E	1	2.26	-	1	1.193	-	-
L3219 TJ150-2E	1	2.34	-	1	1.193	-	-
L3219 TJ150-3E and -3BE	3	2.28	0.006	3	1.192	0.0010	0.08
3 batches from L97	3	2.29	0.04	3	1.193	0.0006	0.05
MN97KVB-0.7							
L3219 TJ164E and TJ175E	2	2.30	-	2	1.189	-	-
LB3219 TJ1209811E	1	2.26	-	1	1.196	-	-
BB3219 TJ1208811E	1	2.33	-	1	1.191	-	-
3 batches from MN97	3	2.30	0.04	3	1.192	0.0036	0.30
L60VB-0.7							
L3219 TJ154E	1	2.28	-	1	1.178	-	-

[a] S.D. = standard deviation.

Table 8. Densities and porosities of cushions from SE54 gum.

Identification	3219d (Mg/m^3)	L/D disks d(Mg/m^3)	L/D disks Porosity (%)	Set disks d(Mg/m^3)	Set disks Porosity (%)
L3260					
TJ115-2EBU-1	1.178	0.5107	56.65	0.5104	56.67
TJ115-2EBU-4	1.180	0.5150	56.36	0.5098	56.80
TJ115-2EBU-7	1.178	0.5024	57.35	0.4979	57.73
TJ115-2BEBU-1	1.177	0.5014	57.40	0.4995	57.56
TJ115-2BEBU-2	1.177	0.5000	57.52	0.4952	57.93
TJ115-2BEBU-3	1.177	0.4997	57.54	0.4966	57.81
TJ115-2BEBU-A	1.177	0.5021	57.34	0.5022	57.33
TJ115-3EBU-IA	1.174	0.5072	56.80	0.5034	57.12
TJ115-3EBU-IIA	1.174	0.5073	56.79	0.5043	57.04
TJ115-3EBU-IIIA	1.174	0.5063	56.87	0.5023	57.21
TJ115-3EBU-IB	1.174	0.5087	56.67	0.5047	57.01
TJ115-3EBU-IIB	1.174	0.5090	56.64	0.5042	57.05
Average of L3260	-	0.5058	56.99	0.5025	57.27
Standard deviation	-	0.0047	0.41	0.0047	0.40
L3223					
TJ115EBU	1.173	0.6544	44.21	0.6491	44.36
TJ115EBU	1.173	0.650	44.59	0.6437	45.12
TJ115ELU	1.173	0.665	43.31	0.6544	44.21
TJ115-2BEBU-A	1.177	0.6672	43.31	0.6635	43.63
TJ115-3EBU-A	1.174	0.6554	44.17	0.6554	44.17
Average of L3223	-	0.6584	43.92	0.6532	44.30
Standard deviation	-	0.0074	0.58	0.0074	0.54

Table 9. Load-deflection and set properties of cushions from SE54 gum.

Identification	3rd cycle load (kPa) at deflections of					Set
	5%	10%	20%	30%	40%	%
L3260						
TJ115-2EBU-1	15.9	26.0	41.0	60.1	102.7	12.22
TJ115-2EBU-4	17.0	27.8	44.7	65.6	110.3	15.53
TJ115-2EBU-7	17.3	27.8	42.7	61.0	100.9	8.91
TJ115-2BEBU-1	18.7	29.8	44.6	62.8	102.5	9.44
TJ115-2BEBU-2	19.5	31.3	47.1	66.3	108.1	8.62
TJ115-2BEBU-3	17.6	28.1	42.6	60.5	98.4	10.32
TJ115-2BEBU-A	17.8	28.5	43.8	62.6	102.7	8.42
TJ115-3EBU-IA	13.7	21.9	34.9	52.0	89.7	18.78
TJ115-3EBU-IIA	14.4	23.2	36.7	54.1	92.2	15.19
TJ115-3EBU-IIIA	15.8	25.3	39.4	57.4	96.4	15.81
TJ115-3EBU-IB	14.6	23.7	37.3	53.9	89.6	18.84
TJ115-3EBU-IIB	15.0	24.3	38.5	56.6	95.9	17.22
Average of L3266	16.4	26.5	41.1	59.4	99.1	13.28
Standard deviation	1.82	2.86	3.76	4.64	6.68	4.05
L3223						
TJ115EBU	28.7	49.3	82.7	133.0	346.1	10.32
TJ115EBU	34.6	58.1	95.2	154.5	386.4	5.89
TJ115ELU	29.7	51.1	85.3	135.9	334.9	7.89
TJ115-2BEBU-A	31.9	54.9	94.9	158.1	421.8	16.65
TJ115-2EBU-A	34.5	58.2	96.3	154.9	398.0	9.83
Average of L3223	31.9	54.3	90.9	147.3	377.4	10.11
Standard deviation	2.70	4.04	6.37	11.8	36.3	4.05

Table 10. Densities and porosities of cushions from L97KVB-0.7 gum.

Identification	3219d (Mg/m^3)	L/D disks d (Mg/m^3)	L/D disks Porosity (%)	Set disks d (Mg/m^3)	Set disks Porosity (%)
L3223					
TJ150EBU	1.193	0.651	45.43	0.6434	46.07
TJ150-2EBU	1.193	0.6559	45.02	0.6456	45.88
TJ150-3BEBU-1	1.192	-	-	0.6561	44.96
TJ150-3BEBU-2	1.192	0.6613	44.52	0.6556	45.00
Average of L3223		0.6561	44.99	0.6502	45.48
Standard deviation		0.0052	0.46	0.0066	0.58
L9755					
TJ150-BEBU-2	1.192	0.5424	54.50	0.5371	54.94
L3260					
TJ150EBU	1.193	0.4989	58.18	0.4948	58.52
TJ150-2EBU	1.193	0.5016	57.96	0.4981	58.25
TJ150-3BEBU-1	1.192	-	-	0.5025	57.84
TJ150-3BEBU-2	1.192	0.5091	57.29	0.5047	57.66
Average of L3260		0.5032	57.81	0.5000	58.07
Standard deviation		0.0053	0.46	0.0044	0.39
L9760					
TJ150-2EBU-I	1.193	0.4878	59.11	0.4803	59.74
L9765					
TJ150-2EBU-II	1.193	0.4132	65.36	0.4118	65.48
L9770					
TJ150-2EBU-III	1.193	0.3664	69.29	0.3751	68.56

Table 11. Load-deflections and set properties of cushions from L97KVB-0.7 gum.

Identification	3rd cycle load (kPa) at deflections of									Set
	5%	10%	20%	30%	40%	45%	50%	55%	60%	%
L3223										
TJ150EBU	72.8	134.3	239.0	378.0	831.1	-	-	-	-	5.53
TJ150-2EBU	78.5	145.1	258.2	417.6	969.2	-	-	-	-	5.66
TJ150-3BEBU-1	-	-	-	-	-	-	-	-	-	5.31
TJ150-3BEBU-2	84.4	156.0	275.5	436.8	988.5	-	-	-	-	-
Average of L3223	78.6	145.1	257.6	410.8	929.6	-	-	-	-	5.50
Standard deviation	5.80	10.9	18.3	30.0	85.8	-	-	-	-	0.18
L9755										
TJ150-3BEBU-2	49.2	87.5	144.9	209.7	337.9	490.9	-	-	-	6.23
L3260										
TJ150EBU	43.0	77.5	126.5	182.9	298.8	-	-	-	-	4.33
TJ150-2EBU	45.5	81.9	132.1	189.3	309.8	-	-	-	-	4.72
TJ150-3BEBU-1	-	-	-	-	-	-	-	-	-	4.90
TJ150-3BEBU-2	45.7	80.3	132.1	191.9	313.6	472.1	-	-	-	-
Average of L3260	44.7	79.7	130.2	188.0	307.4					4.65
Standard deviation	1.50	3.11	3.23	4.63	7.69					0.29
L9760										
TJ150-2EBU-I	35.8	64.4	106.9	152.4	234.3	319.2	502.7	-	-	6.04
L9765										
TJ150-2EBU-II	25.8	44.4	70.6	98.8	145.3	-	263.4	434.2	-	4.69
L9770										
TJ150-2EBU-III	16.2	27.6	44.9	64.3	94.3	-	159.0	232.2	399.4	4.85

Table 12. Densities and porosities of cushions from MN97KVB-0.7 gum.

Identification	3219d (Mg/m^3)	L/D disks d (Mg/m^3)	L/D disks Porosity (%)	Set disks d (Mg/m^3)	Set disks Porosity (%)
L3223					
TJ164ELU	1.189	0.6565	44.69	0.6572	44.63
LB3223					
TJ120981lEBU	1.196	0.6558	45.17	0.6553	45.21
LBB3223					
TJ120881lEBU-1	1.191	0.6574	44.90	0.6547	45.12
Average of 3223		0.6566	44.92	0.6557	44.99
Standard deviation		0.0008	0.24	0.0013	0.31
LB9750					
TJ120981lEBU-1	1.196	0.5837	51.20	0.5828	51.27
LB9755					
TJ120981lEBU	1.196	0.5268	55.95	0.5283	55.83
LBB9755					
TJ120881lEBU-1	1.191	0.5558	55.09	0.5340	55.24
Average of 9755	-	-	-	-	55.54
Standard deviation	-	-	-	-	0.42
L3260					
TJ175ELU	1.189	0.5226	56.12	0.5205	56.15
LB9760					
TJ120981lEBU	1.196	0.4767	60.14	0.4715	60.58
LB9770					
TJ120981lEBU-1	1.196	0.3388	71.67	0.3362	71.89

Table 13. Load-deflection and set properties of cushions from MN97KVB-0.7 gum.

Identification	3rd cycle load (kPa) at deflections of								Set
	5%	10%	20%	30%	40%	45%	50%	60%	%
L3223									
TJ164ELU	62.5	119.9	217.9	344.6	742.1	-	-	-	5.91
LB3223									
TJ120981lEBU	73.5	144.5	264.5	422.2	947.2	-	-	-	6.07
LBB3223									
TJ120881lEBU-1	65.4	127.9	232.8	367.0	792.7	-	-	-	5.31
Average of 3223	67.1	130.8	238.4	377.9	827.3	-	-	-	5.76
Standard deviation	5.70	12.5	23.8	39.9	106.8	-	-	-	0.40
LB9750									
TJ120981lEBU-1	44.9	85.1	149.4	223.9	385.3	621.9	-	-	4.95
LB9755									
TJ120981lEBU	36.1	66.2	113.3	167.5	273.0	-	701.6	-	5.60
LBB9755									
TJ120881lEBU-1	31.7	59.8	104.9	155.6	251.2	357.8	613.7	-	5.41
Average of 9755	33.9	63.0	109.1	161.6	262.1	-	657.7	-	5.51
Standard deviation	-	-	-	-	-	-	-	-	0.13
L3260									
TJ175ELU	34.8	63.5	108.5	161.1	266.3	-	-	-	4.59
LB9760									
TJ120981lEBU	26.6	47.4	79.3	114.5	176.2	237.0	362.1	-	4.27
LB9770									
TJ120981lEBU-1	12.1	20.8	33.2	45.7	63.8	-	99.7	219.5	8.78

Table 14. Densities and porosities of cushions from L60VB-0.7 gum.

Identification	3219d (Mg/m^3)	L/D disks d(Mg/m^3)	L/D disks Porosity (%)	Set disks d(Mg/m^3)	Set disks Porosity (%)
L3223					
TJ154EBU	1.178	0.6466	45.11	0.6442	45.31
L6050					
TJ154EBU-1	1.178	0.5827	50.53	-	-
TJ154EBU-1-Repeat-1	1.178	0.5784	50.90	0.5763	51.08
Average of L6050		0.5806	50.72	-	-
L6055					
TJ154EBU-1	1.178	0.5293	55.07	-	-
L3260					
TJ154EBU	1.178	0.5027	57.33	0.5129	56.46
L6060					
TJ154EBU-1	1.178	0.4630	60.70	0.4572	61.19
L6065					
TJ154EBU-II	1.178	0.4141	64.85	0.4154	64.74
L6070					
TJ154EBU-1	1.178	0.3383	71.28	-	-

Table 15. Load-deflection and set properties of cushions from L60VB-0.7 gum.

Identification	3rd cycle load (kPa) at deflections of									Set
	5%	10%	20%	30%	40%	45%	50%	55%	60%	%
L3223										
TJ154EBU	60.5	116.4	209.4	329.8	703.1	-	-	-	-	3.84
L6050										
TJ154EBU-1	49.8	94.8	167.2	252.2	444.6	744.9	-	-	-	-
TJ154EBU-Repeat-1	45.4	86.1	150.1	222.6	381.3	615.9	-	-	-	4.41
Average of L6050	47.6	90.5	158.7	237.4	413.0	680.4	-	-	-	-
L6055										
TJ154EBU-1	34.1	62.9	107.7	158.2	254.3	362.5	-	-	-	-
L3260										
TJ154EBU	33.5	60.8	101.5	145.5	229.1	-	-	-	-	3.30
L6060										
TJ154EBU-I	26.0	48.1	79.9	112.9	169.7	224.8	333.3	-	-	5.14
L6065										
TJ154EBU-II	17.0	33.4	57.8	82.6	122.0	-	217.9	351.2	-	4.96
L6070										
TJ154EBU-1	11.4	19.9	32.2	45.1	63.9	-	101.3	-	230.0	-

Table 16. Theoretical and experimental densities and porosities of L60VB-0.7 cushions as a function of urea loading in the molding compound.

Theoretical	Urea g	Urea wt%	Urea cc	3219 plus 497XL g	3219 plus 497XL cc	Total g	Total cc	Porosity (%)	d (Mg/m^3)
L3223	100	50.50	74.63	102	86.59	202	161.22	46.29	0.6327
L6050	130	56.03	97.01	102	86.59	232	183.60	52.84	0.5556
L6055	161	61.22	120.15	102	86.59	263	206.74	58.12	0.4934
L3260	170	62.50	126.87	102	86.59	272	213.46	62.93	0.4778
L6060	197	65.89	147.01	102	86.59	299	233.60	59.44	0.4366
L6065	241	70.26	179.85	102	86.59	343	266.44	67.50	0.3829
L6070	325	76.11	242.54	102	86.59	427	329.13	73.69	0.3099

Experimental		Porosity (%) n	Porosity (%) av	Porosity (%) S.D.	Density (Mg/m^3) n	Density (Mg/m^3) av	Density (Mg/m^3) S.D.
L3323	100	2	45.21	0.14	2	0.6454	0.0017
L6050	130	4	50.79	0.25	4	0.5797	0.0030
L6055	161	2	55.11	0.05	2	0.5289	0.0006
L3260	170	2	56.90	0.62	2	0.5078	0.0072
L6060	197	2	60.95	0.35	2	0.4601	0.0041
L6065	241	2	64.80	0.08	2	0.4148	0.0009
L6070	325	2	71.32	0.05	2	0.3379	0.0006

Table 17. Experimental densities and porosities of L60VB-0.7 and MN97KVB-0.7 cushions as a function of urea loading in the molding compound.

	Urea			Porosity		Density, Mg/m^3		
Name	Parts[a]	wt%	n	av	S.D.	n	av	S.D.
L97-L3223	100	50.50	7	45.27	0.55	7	0.6528	0.0065
MN97-L3223	100	50.50	6	44.94	0.28	6	0.6557	0.0010
MN97-L9750	129	55.84	2	51.24	-	2	0.5833	-
L97-L9755	151	59.68	2	54.72	-	2	0.5398	-
MN97-L9755	163	61.51	4	55.65	0.56	4	0.5260	0.0060
L97-L3260	170	62.50	6	57.96	0.41	6	0.5014	0.0047
MN97-L3260	170	62.50	2	56.14	-	2	0.5216	-
L97-L9760	185	64.46	2	59.42	-	2	0.4840	-
MN97-L9760	194	65.54	2	60.36	-	2	0.4741	-
L97-L9765	234	69.64	2	65.42	-	2	0.4125	-
L97-L9770	285	73.64	2	69.43	-	2	0.3708	-
MN97-L9770	327	76.22	2	71.78	-	2	0.3375	-

[a] Parts of urea per 100 parts of 3219 plus 2 parts of 497XL, by wt.

Table 18. Correlation of cushion porosity with cushion density and parts of urea/100 parts of L3219 plus 2 parts of 497XL (by weight).

Porosity (%)	L97KVB-0.7 and MN97KVB-0.7[a] d (Mg/m^3)	Urea parts	parts	L60VB-0.7[b] d (Mg/m^3)	Urea parts	parts
45	0.656	99	104	0.646	99	104
50	0.602	122	127	0.578	131	127
55	0.537	153	154	0.525	158	156
60	0.470	191	189	0.470	191	192
65	0.416	231	235	0.422	233	241
70	0.364	293	298	0.357	303	308

[a] See Fig. 12 [Eq. (1)].
[b] See Fig. 11 [Eq. (2)].

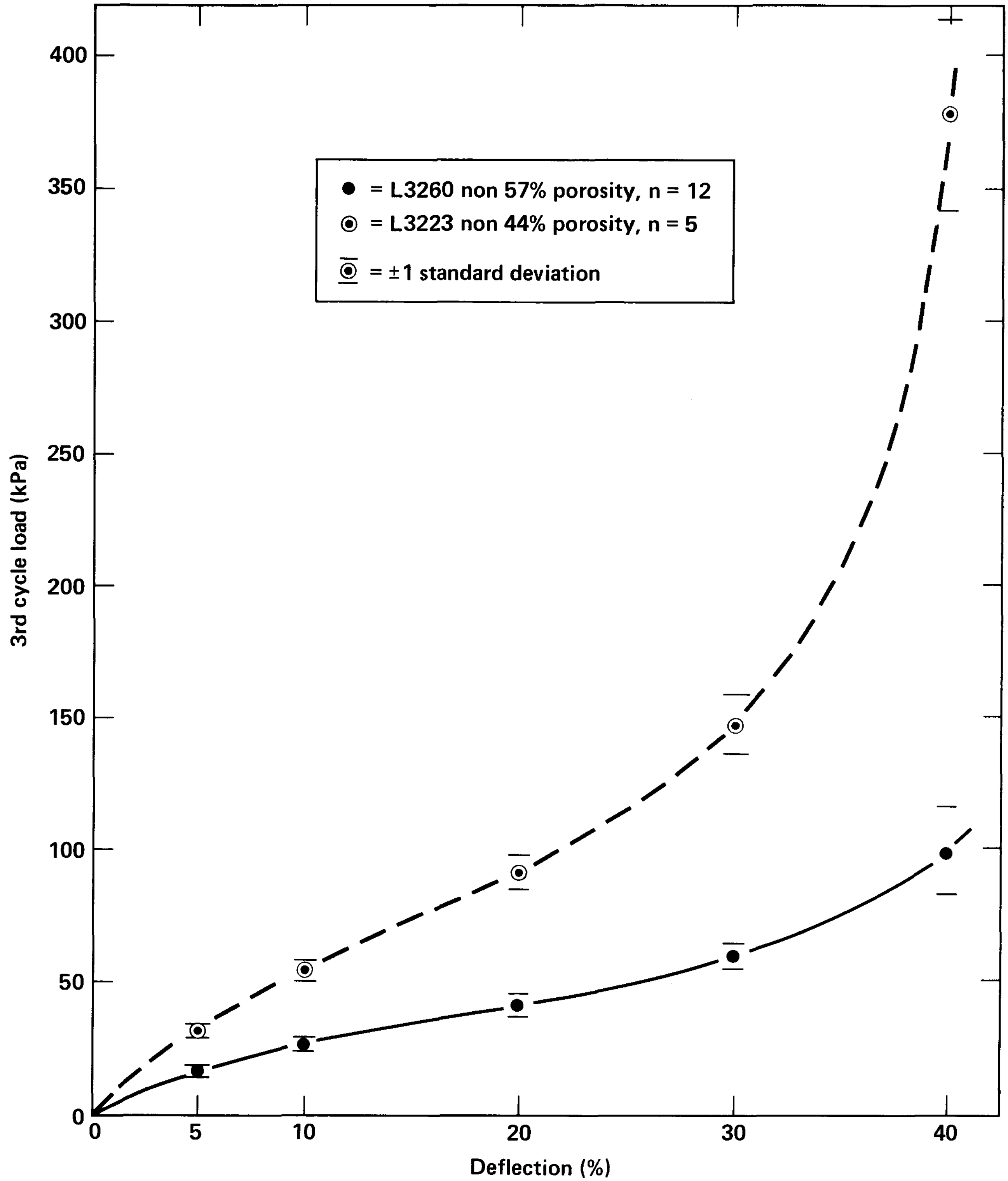

Figure 1. Load-deflection of cellular silicones from SE54 gum.

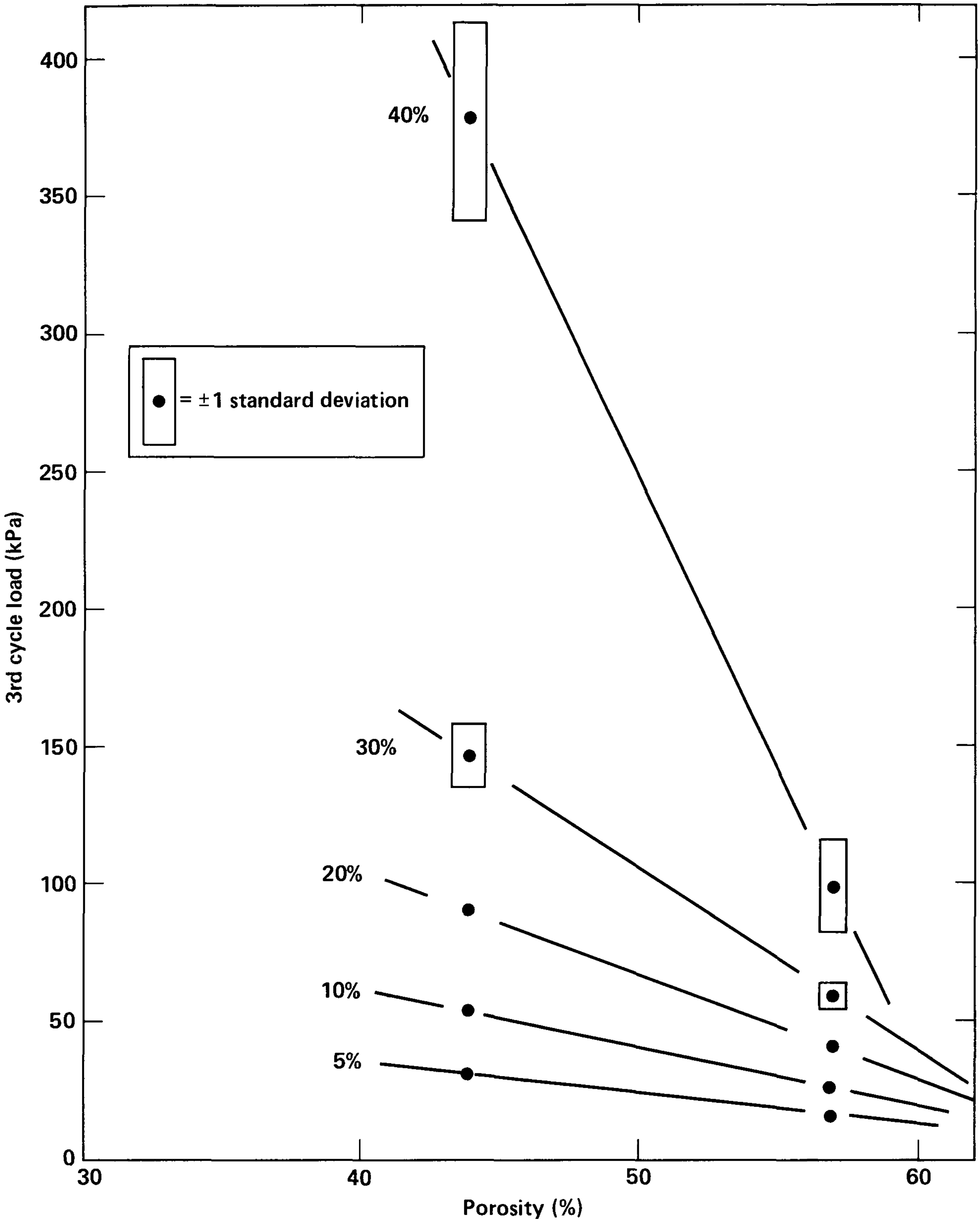

Figure 2. Load at various deflections as a function of porosity of cellular silicones from SE54 gum.

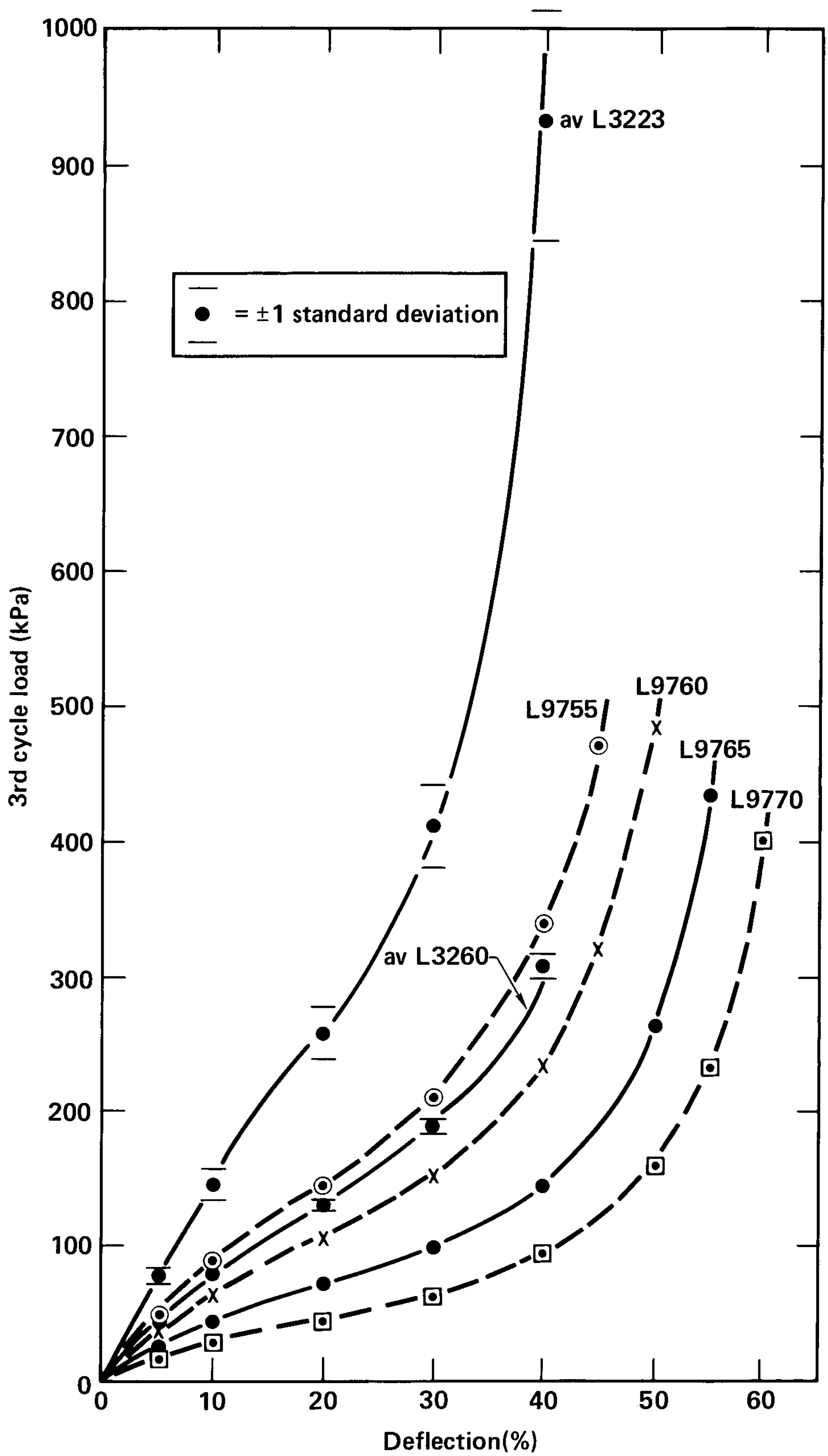

Figure 3. Load-deflection of cellular silicones from L97KVB-0.7 gum.

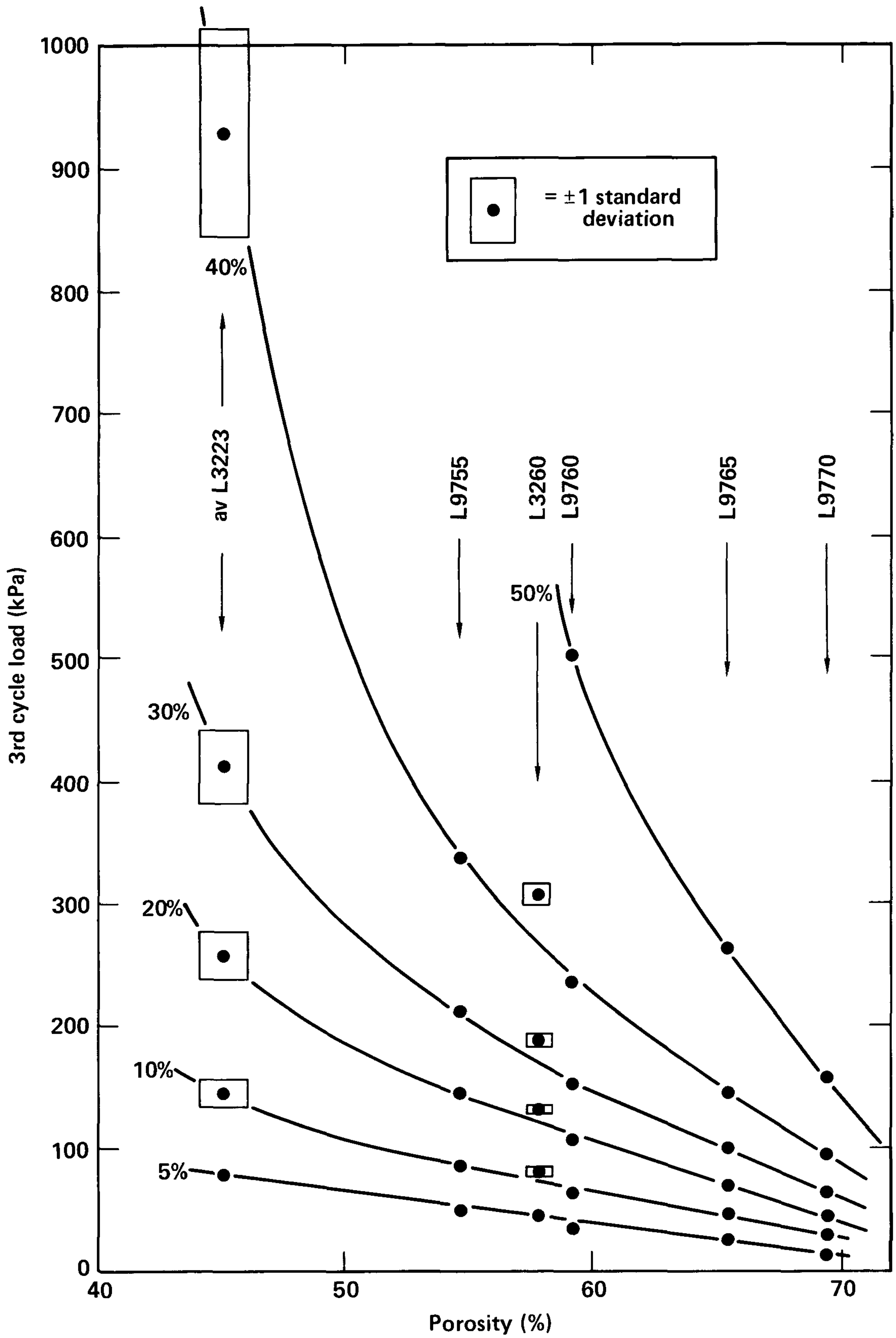

Figure 4. Load at various deflections as a function of porosity of cellular silicones from L97KVB-0.7 gum.

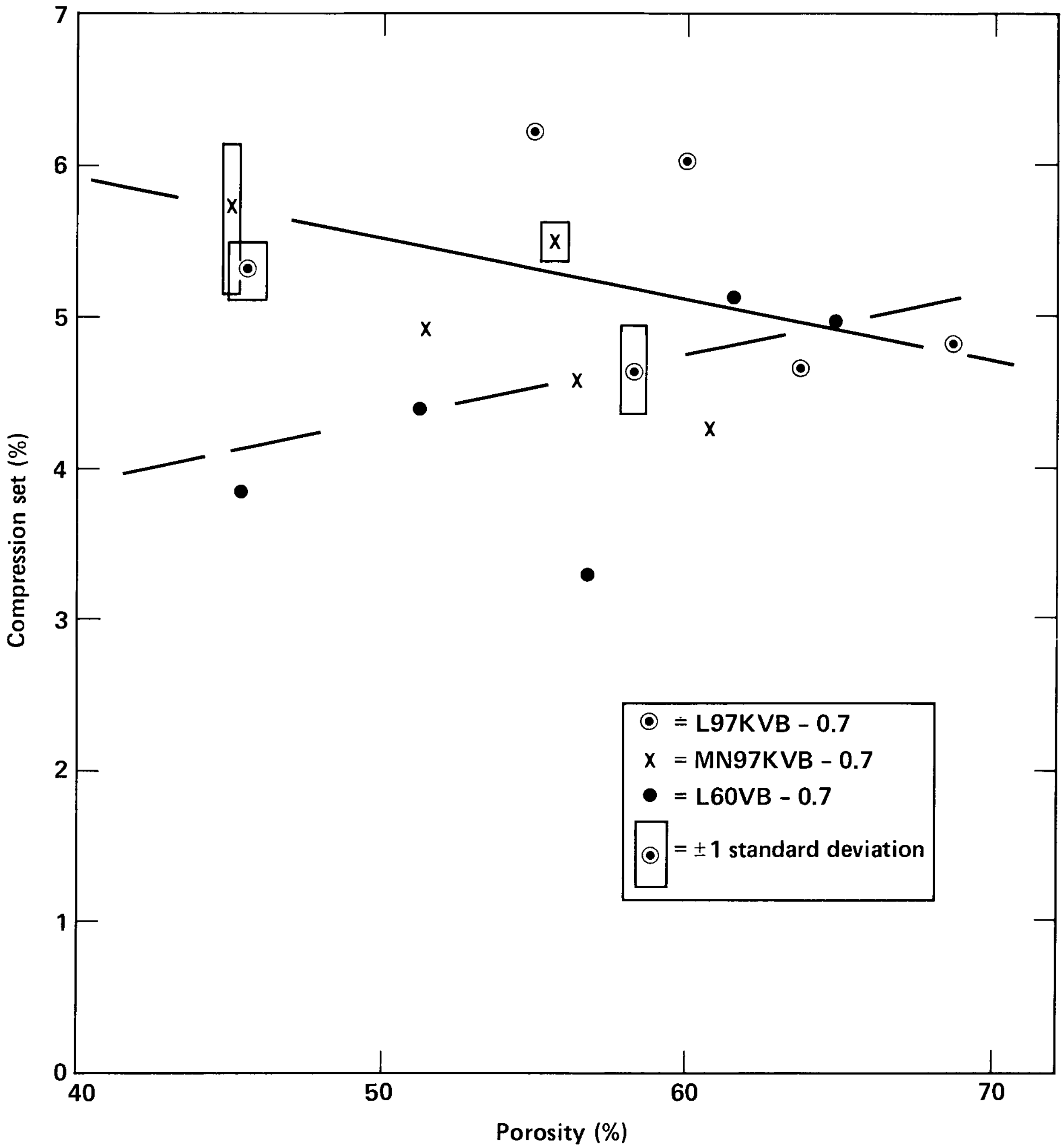

Figure 5. Compression set as a function of porosity of cellular silicone from three silicone gums.

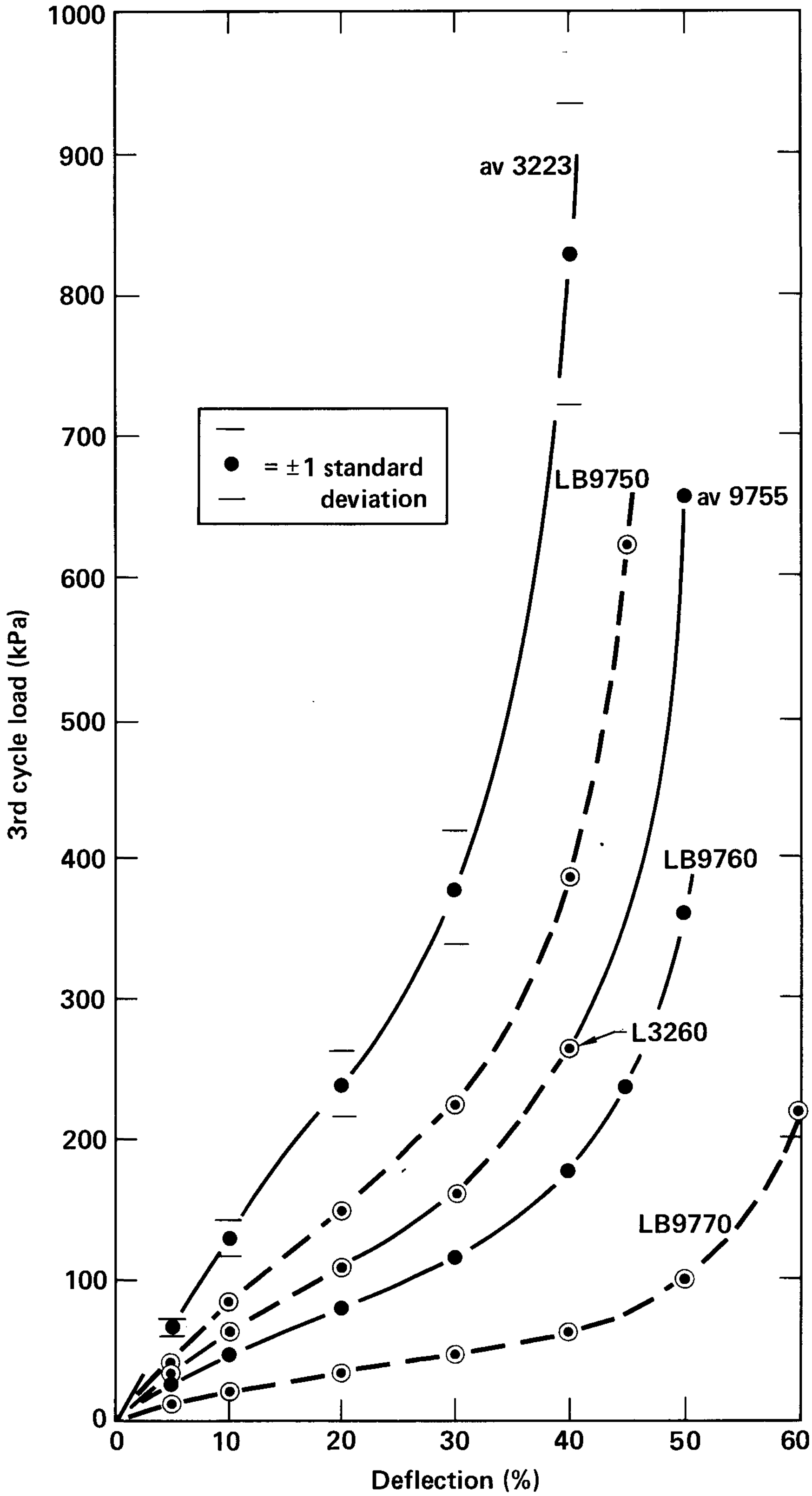

Figure 6. Load-deflection of cellular silicones from MN97KVB-0.7 gum.

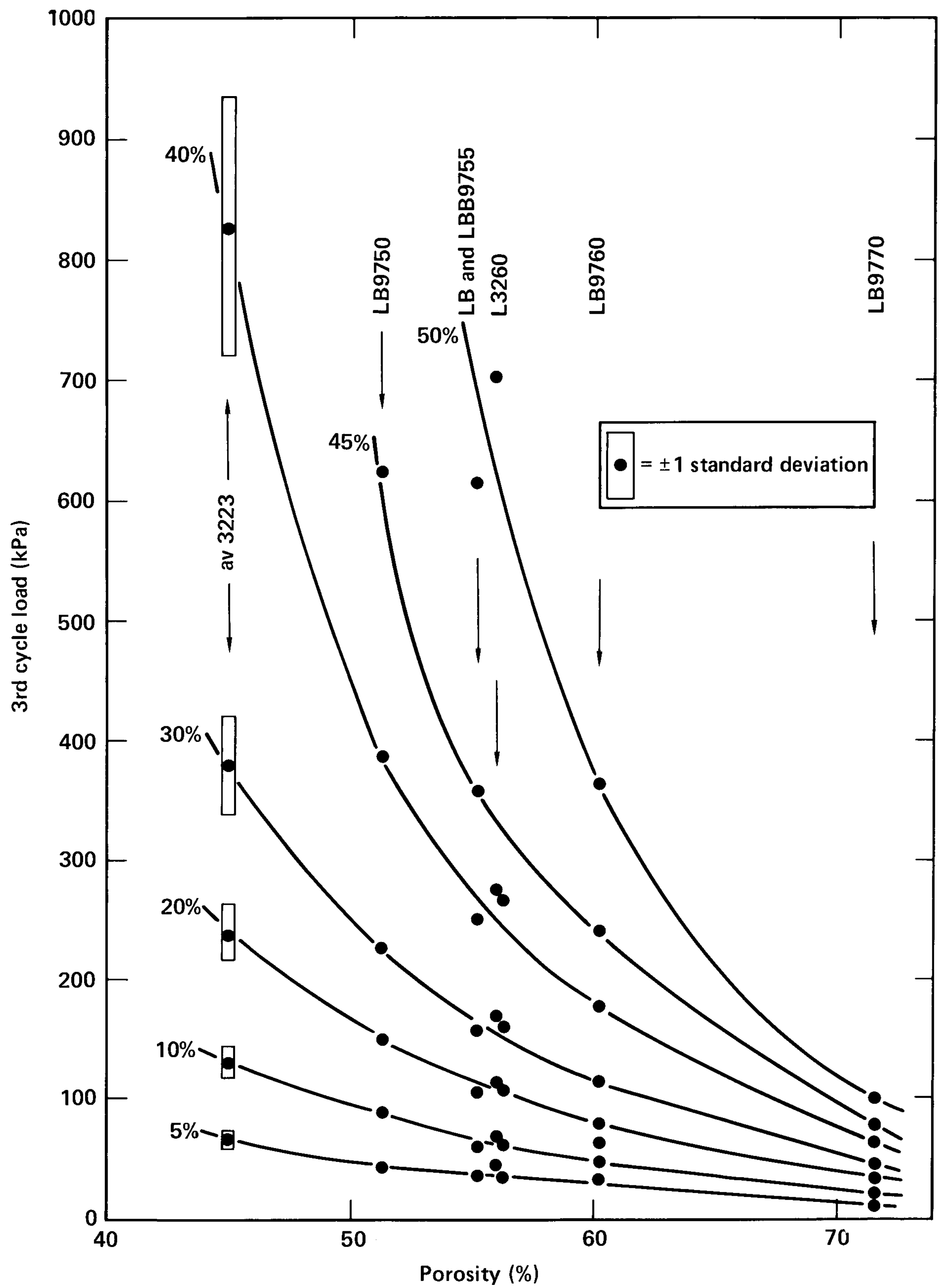

Figure 7. Load at various deflections as a function of porosity of cellular silicones from MN97KVB-0.7 gum.

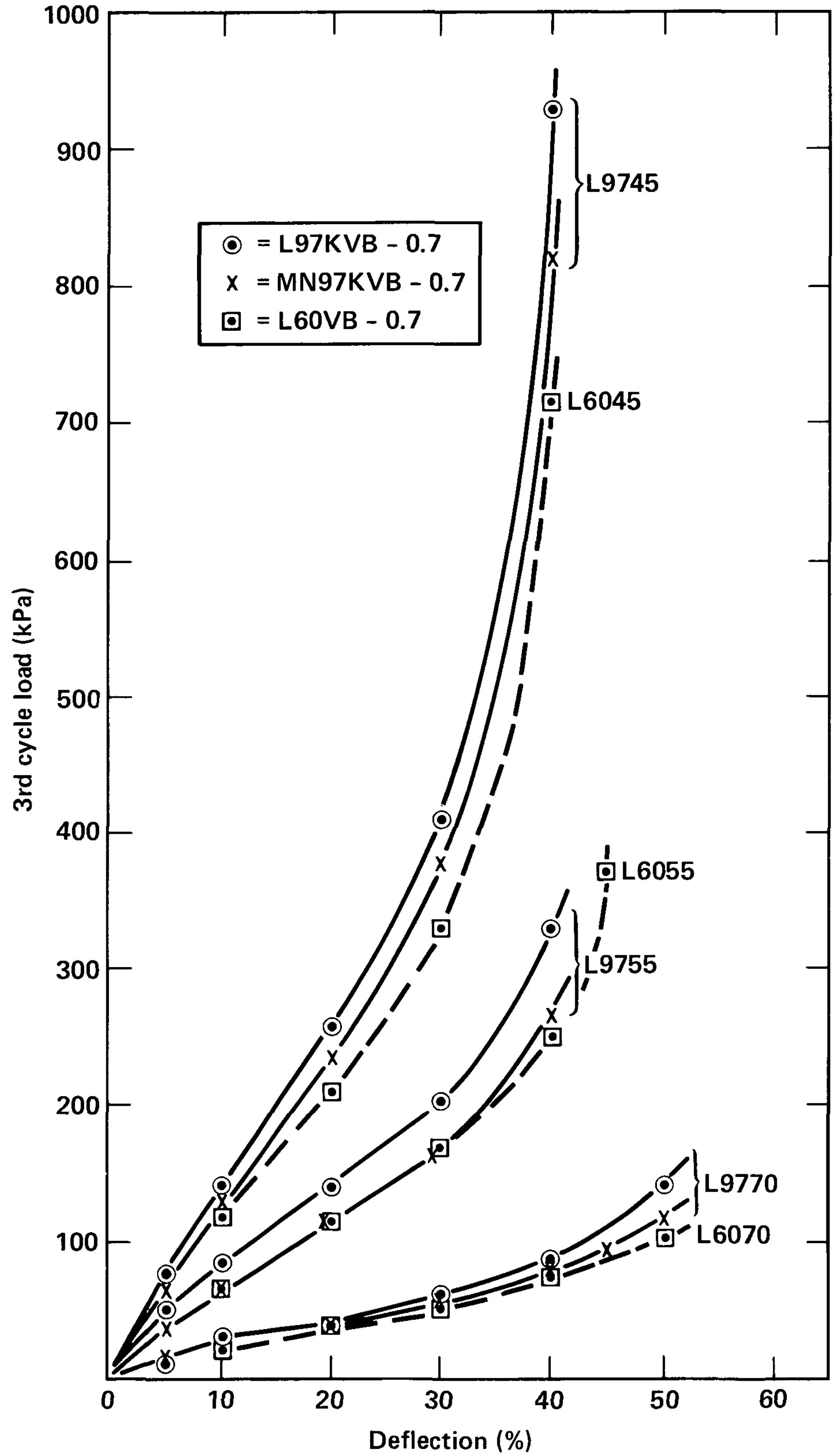

Figure 8. Comparisons of load-deflections of L97KVB-0.7, MN97KVB-0.7, and L60KVB-0.7 at three equal porosities.

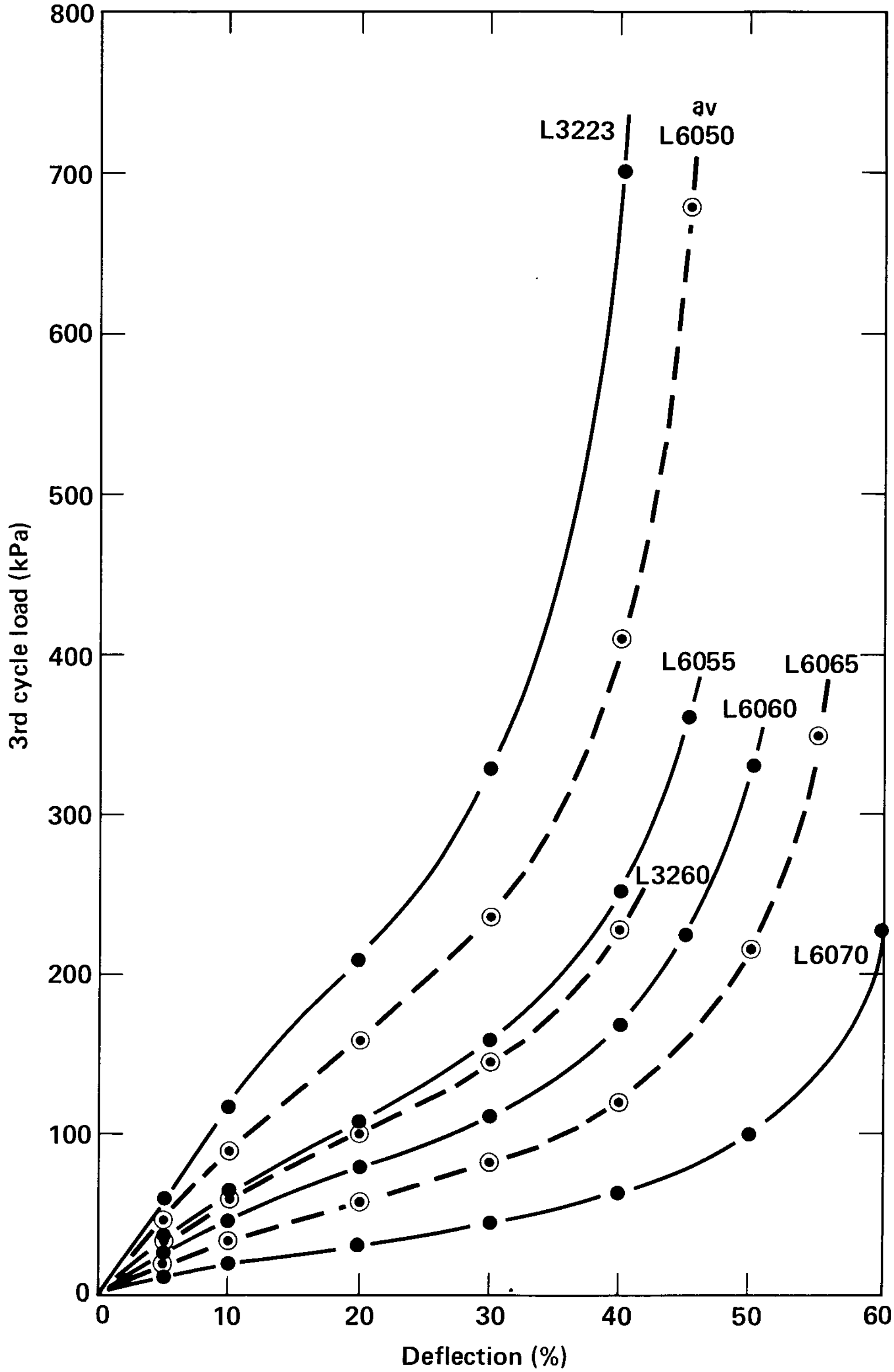

Figure 9. Load-deflection of cellular silicones from L60VB-0.7 gum.

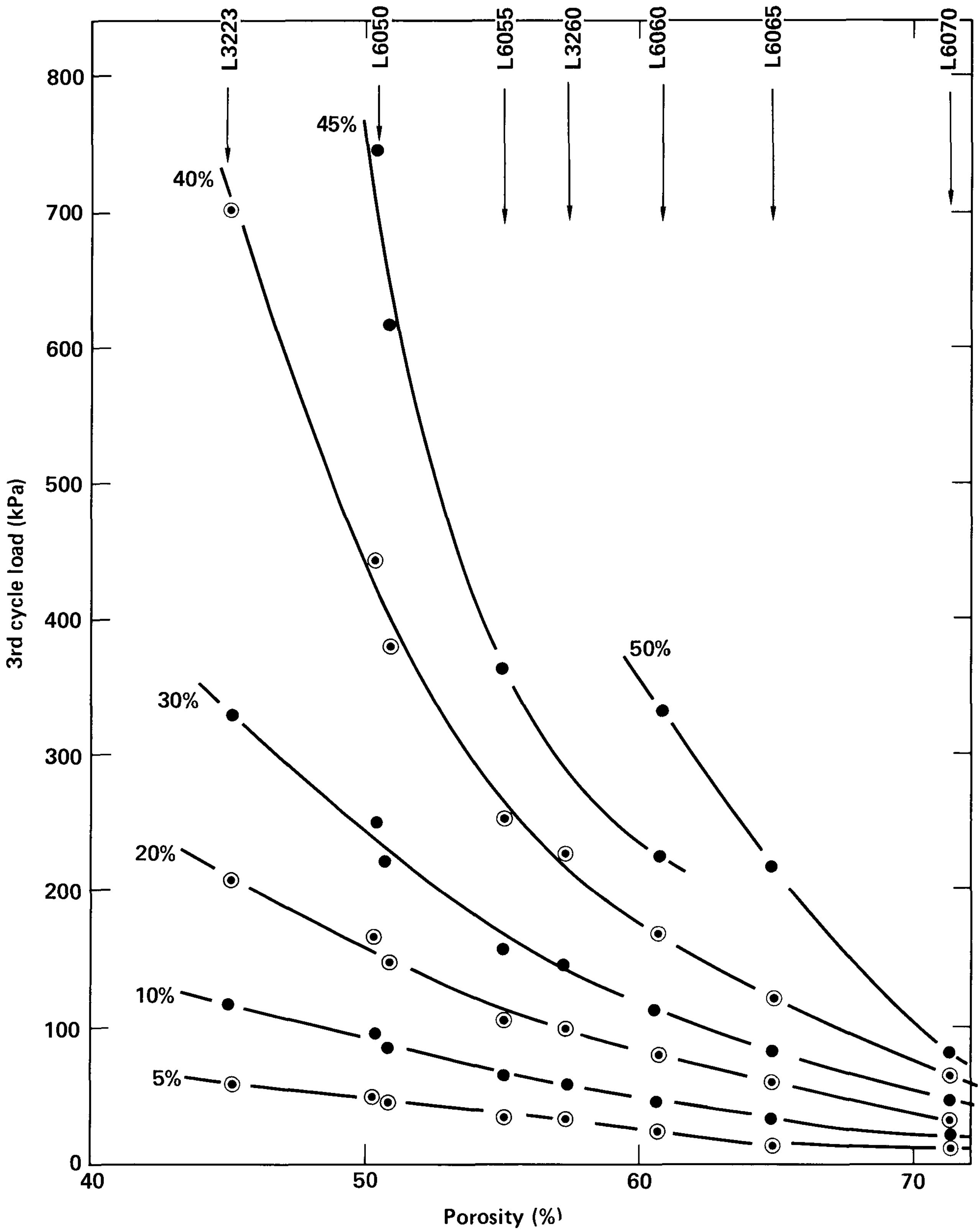

Figure 10. Load at various deflections as a function of porosity of cellular silicones from L60VB-0.7 gum.

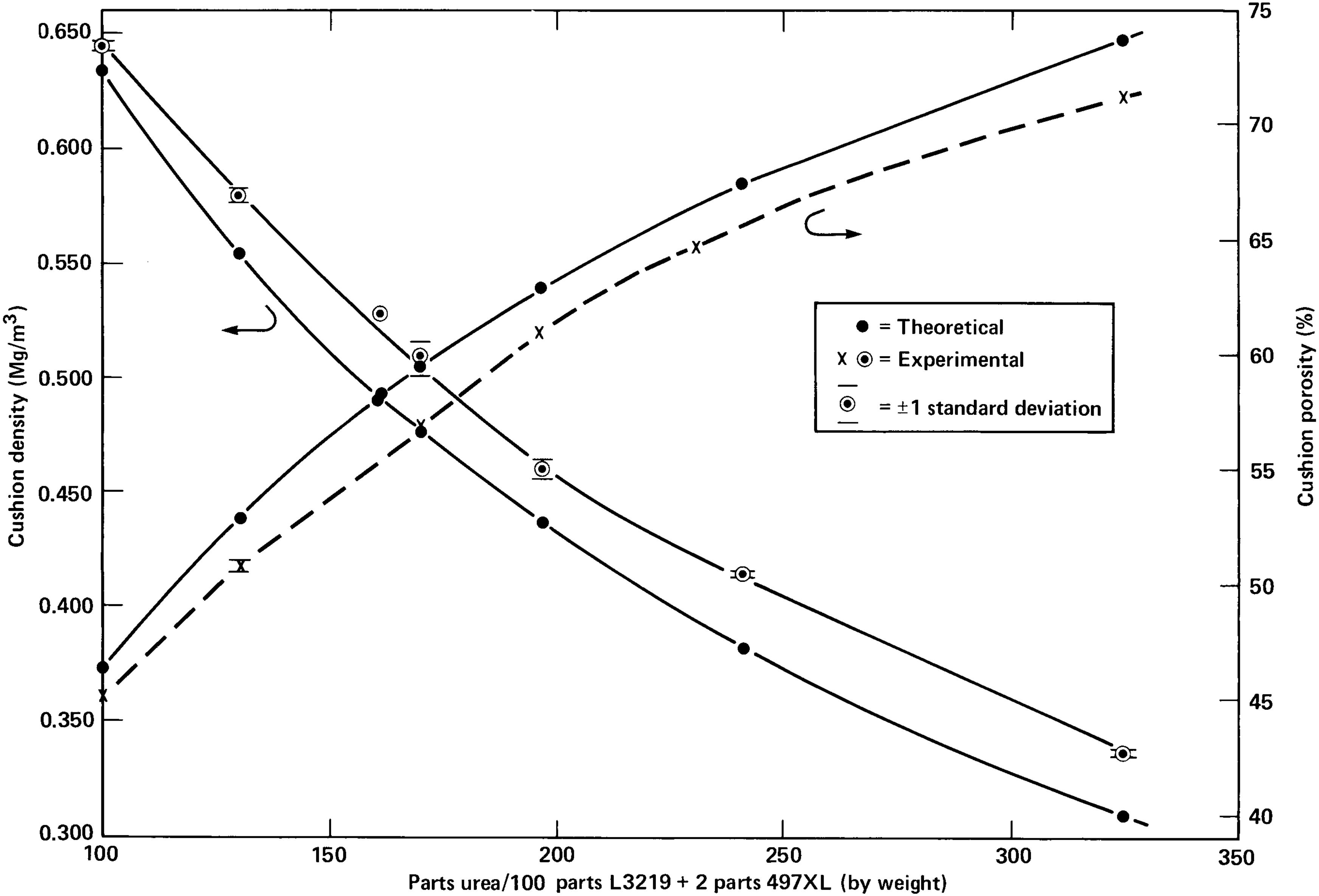

Figure 11. Correlation of L60VB-0.7 cushion density and porosity with parts of urea/100 parts of L3219 plus 2 parts of 497XL (by weight) in the molding compound.

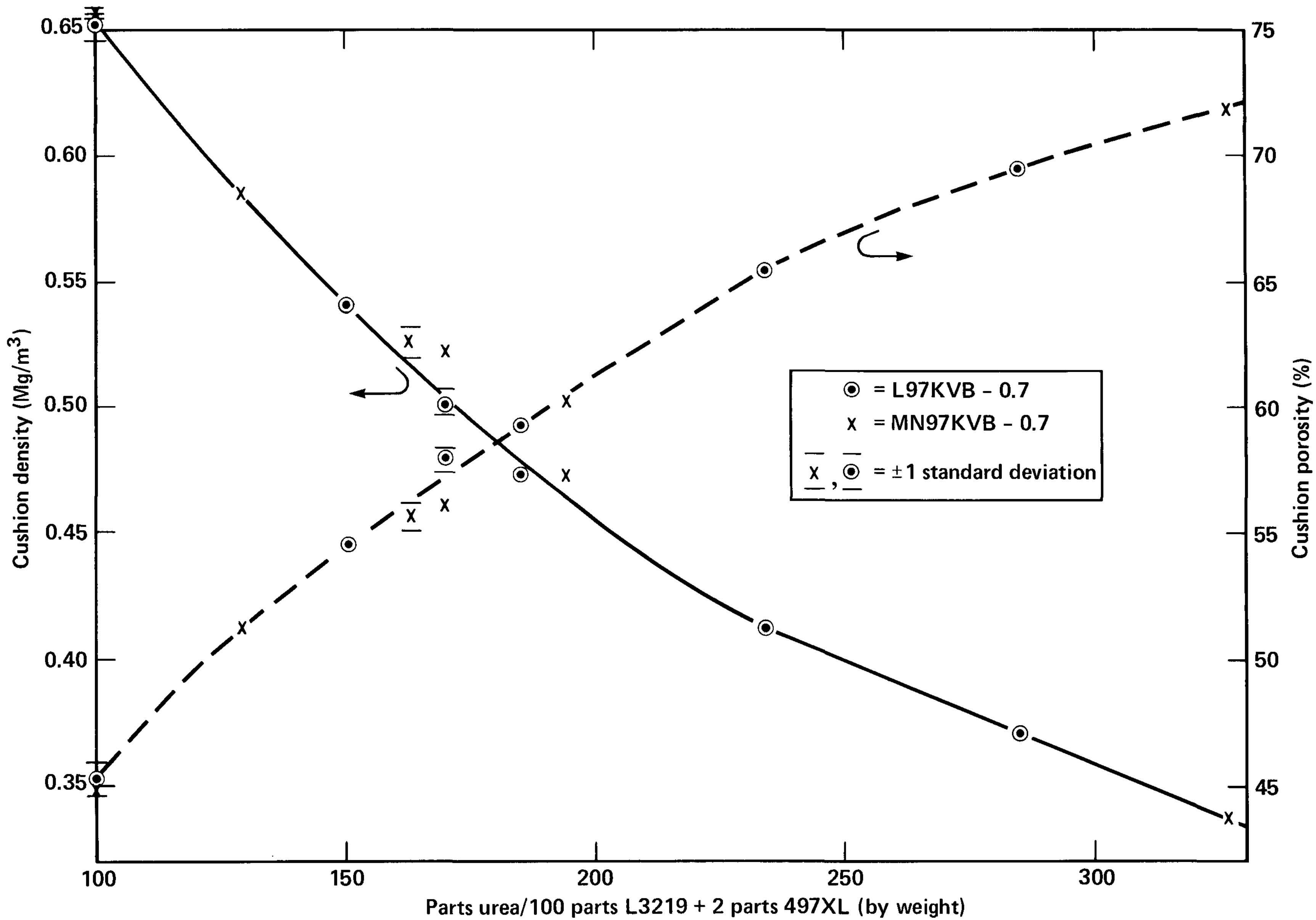

Figure 12. Correlation of cushion density and porosity with parts of urea/100 parts of L3219 plus 2 parts 497XL (by weight) in the molding compound.

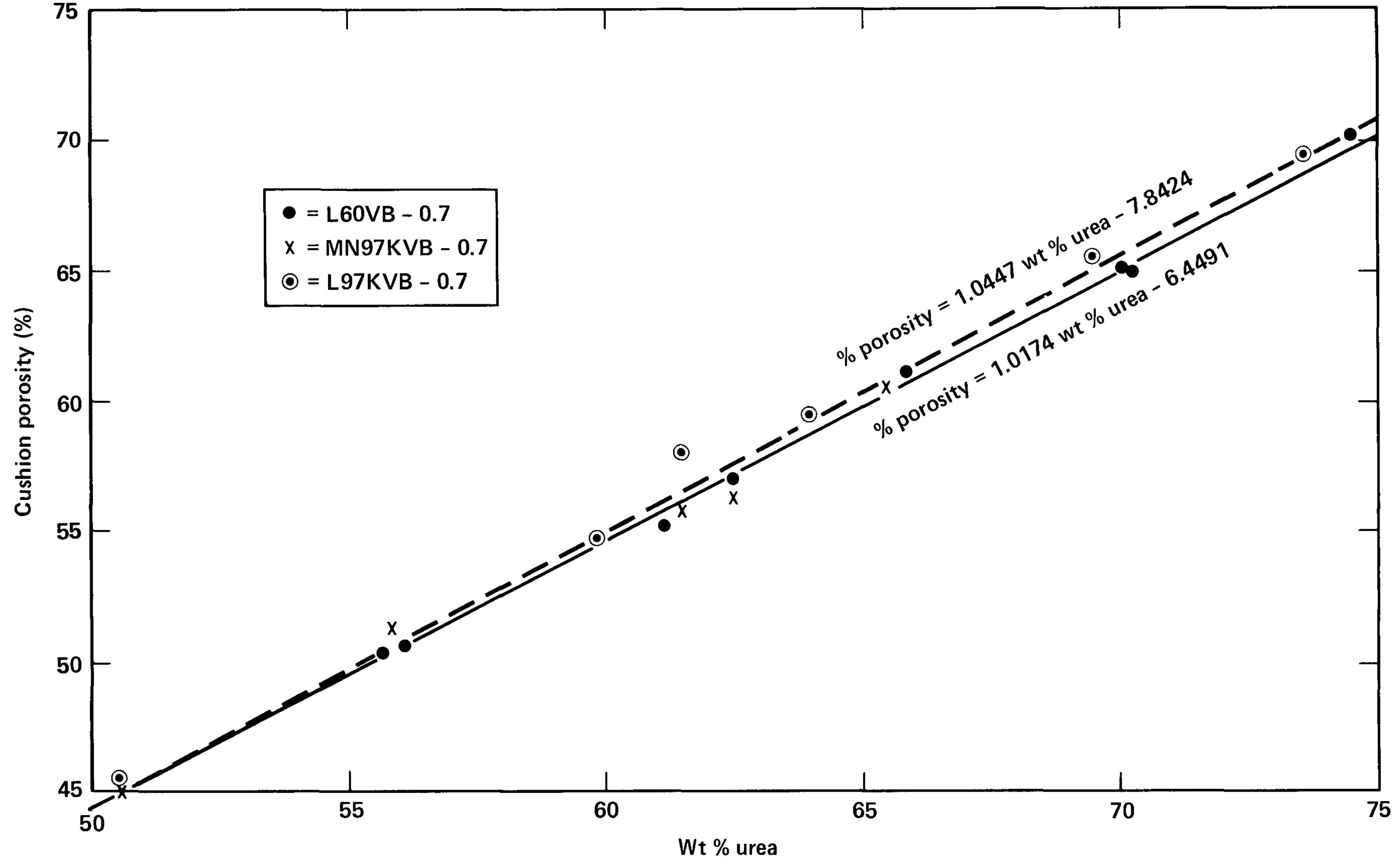

Figure 13. Correlation of cushion porosity with the weight percent of urea in the molding compound.

APPENDIX A

Table A-1. Properties of cushions from SE54 gum.

	L3260-TJ115-2EBU								
	-1			-4			-7		
	n	av	S.D.	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)									
L/D disks	5	0.5107	0.0027	5	0.5150	0.0012	5	0.5024	0.0038
Set disks	5	0.5104	0.0111	3	0.5098	0.0001	5	0.4979	0.0014
3rd cycle load (kPa)									
5% deflection	3	15.9	0.69	2	17.0	-	4	17.3	0.38
10% deflection	3	26.0	1.04	2	27.8	-	4	27.8	0.50
20% deflection	3	41.0	1.13	2	44.7	-	4	42.7	0.76
30% deflection	3	60.1	0.67	2	65.6	-	4	61.0	1.32
40% deflection	3	102.7	2.13	2	110.3	-	4	100.9	3.63
3rd cycle unload (kPa)									
5% deflection	3	9.0	0.40	2	10.1	-	4	10.1	0.25
10% deflection	3	16.3	0.68	2	18.0	-	4	17.8	0.39
20% deflection	3	27.0	0.71	2	30.0	-	4	28.2	0.49
30% deflection	3	41.2	0.54	2	46.0	-	4	41.8	0.67
40% deflection	3	77.9	2.72	2	85.8	-	4	75.8	2.44
Unload/load ratio									
10% deflection	3	0.628	0.0017	2	0.646	-	4	0.640	0.0050
20% deflection	3	0.659	0.0015	2	0.673	-	4	0.660	0.0051
30% deflection	3	0.689	0.0025	2	0.700	-	4	0.685	0.0047
40% deflection	3	0.758	0.0114	2	0.778	-	4	0.751	0.0078
Hysteresis loop[a]	3	96.1	3.47	2	96.4	-	4	97.2	6.22
3rd cycle t (mm)	3	2.57	0.007	2	2.63	-	4	2.66	0.023
Δt (mm)[b]	3	0.094	0.0208	2	0.101	-	4	0.078	0.0091
Set (%)	5	12.22	2.46	3	15.53	3.53	5	8.91	2.10
Recovery (%)									
1 h	5	95.11	0.99	3	93.79	1.39	5	96.43	0.84
7 d	5	97.51	0.27	3	96.92	0.60	5	98.35	0.18
% compression for set	5	39.99	0.14	3	39.99	0.15	5	40.06	0.12

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-2. Properties of cushions from SE54 gum.

	L3260-TJ115-2BEBU								
	-1			-2			-3		
	n	av	S.D.	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)									
L/D disks	5	0.5014	0.0031	5	0.5000	0.0047	5	0.4997	0.0011
Set disks	3	0.4995	0.0003	3	0.4952	0.0040	3	0.4966	0.0013
3rd cycle load (kPa)									
5% deflection	5	18.7	0.24	4	19.5	0.78	5	17.6	0.71
10% deflection	5	29.8	0.21	4	31.3	1.61	5	28.1	1.20
20% deflection	5	44.6	0.35	4	47.1	2.36	5	42.6	1.69
30% deflection	5	62.8	0.69	4	66.3	2.75	5	60.5	1.93
40% deflection	5	102.5	2.07	4	108.1	3.83	5	98.4	1.99
3rd cycle unload (kPa)									
5% deflection	5	10.8	0.22	4	11.6	0.60	5	10.7	0.58
10% deflection	5	18.5	0.24	4	20.0	1.25	5	18.1	0.99
20% deflection	5	28.4	0.42	4	30.7	1.76	5	27.9	1.37
30% deflection	5	41.4	0.90	4	44.6	1.97	5	40.8	1.60
40% deflection	5	73.1	3.35	4	78.5	1.81	5	71.9	1.96
Unload/load ratio									
10% deflection	5	0.621	0.0049	4	0.639	0.0076	5	0.644	0.0085
20% deflection	5	0.638	0.0051	4	0.653	0.0061	5	0.656	0.0068
30% deflection	5	0.658	0.0080	4	0.672	0.0048	5	0.674	0.0052
40% deflection	5	0.713	0.0202	4	0.727	0.0097	5	0.730	0.0065
Hysteresis loop[a]	5	121.5	7.71	4	122.3	10.2	5	106.1	3.73
3rd cycle t (mm)	5	2.64	0.027	4	2.66	0.009	5	2.65	0.0017
Δt (mm)[b]	5	0.080	0.0069	4	0.078	0.0019	5	0.065	0.0041
Set, %	3	9.44	1.48	3	8.62	1.04	3	10.32	0.95
Recovery (%)									
1 h	3	96.22	0.59	3	96.52	0.41	3	95.84	0.40
7 d	3	98.06	0.09	3	98.03	0.25	3	98.04	0.06
% compression for set	3	40.00	0.061	3	40.35	0.55	3	40.25	0.45

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-3. Properties of cushions from SE54 gum.

	L3260			L3260-TJ115-3EBU					
	TJ115-2BEBU-A			IB			IIB		
	n	av	S.D.	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)									
L/D disks	5	0.5021	0.0040	5	0.5087	0.0032	5	0.5090	0.0030
Set disks	3	0.5022	0.0003	3	0.5047	0.0021	3	0.5042	0.0019
3rd cycle load (kPa)									
5% deflection	4	17.8	0.26	1	14.6	-	4	15.0	0.31
10% deflection	4	28.5	0.60	1	23.7	-	4	24.3	0.46
20% deflection	4	43.8	0.79	1	37.3	-	4	38.5	0.61
30% deflection	4	62.6	0.61	1	53.9	-	4	56.6	0.82
40% deflection	4	102.7	1.42	1	89.6	-	4	95.9	1.30
3rd cycle unload (kPa)									
5% deflection	4	10.9	0.23	1	8.3	-	4	8.3	0.20
10% deflection	4	18.7	0.53	1	14.9	-	4	14.9	0.27
20% deflection	4	29.4	0.71	1	24.5	-	4	24.7	0.36
30% deflection	4	43.3	0.62	1	36.9	-	4	37.7	0.56
40% deflection	4	76.8	0.63	1	66.2	-	4	70.0	1.32
Unload/load ratio									
10% deflection	4	0.657	0.0053	1	0.630	-	4	0.614	0.0031
20% deflection	4	0.673	0.0045	1	0.659	-	4	0.641	0.0012
30% deflection	4	0.692	0.0051	1	0.685	-	4	0.665	0.0022
40% deflection	4	0.747	0.0053	1	0.739	-	4	0.730	0.0072
Hysteresis loop[a]	4	103.6	4.09	1	96.1	-	4	95.6	4.39
3rd cycle t (mm)	4	2.64	0.017	1	2.55	-	4	2.57	0.0017
Δt (mm)[b]	4	0.070	-	1	0.055	-	4	0.077	-
Set (%)	3	8.42	1.37	3	18.84	2.21	3	17.22	3.34
Recovery (%)									
1 h	3	96.62	0.55	3	92.46	0.87	3	93.11	1.33
7 d	3	98.15	0.25	3	96.04	0.17	3	96.40	0.26
% compression for set	3	40.12	0.068	3	40.01	0.20	3	40.01	0.071

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-4. Properties of cushions from SE54 gum.

	L3260-TJ115-3EBU								
	IA			IIA			IIIA		
	n	av	S.D.	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)									
L/D disks	5	0.5072	0.0008	5	0.5073	0.0019	5	0.5063	0.0022
Set disks	3	0.5034	0.0012	3	0.5043	0.0006	3	0.5023	0.0013
3rd cycle load (kPa)									
5% deflection	2	13.7	0.54	2	14.4	0.39	4	15.8	0.23
10% deflection	2	21.9	0.99	2	23.2	0.64	4	25.3	0.27
20% deflection	2	34.9	1.46	2	36.7	0.84	4	39.4	0.28
30% deflection	2	52.0	1.63	2	54.1	0.97	4	57.4	0.32
40% deflection	2	89.7	2.16	2	92.2	0.85	4	96.4	0.77
3rd cycle unload, kPa									
5% deflection	2	7.2	0.54	2	7.8	0.34	4	8.8	0.16
10% deflection	2	12.9	0.88	2	13.9	0.55	4	15.5	0.16
20% deflection	2	21.7	1.23	2	23.1	0.85	4	25.2	0.18
30% deflection	2	33.5	1.46	2	35.5	1.08	4	38.0	0.19
40% deflection	2	62.8	1.70	2	65.8	1.48	4	69.7	0.43
Unload/load ratio									
10% deflection	2	0.589	0.0136	2	0.600	0.0074	4	0.614	0.0019
20% deflection	2	0.621	0.0094	2	0.631	0.0089	4	0.639	0.0013
30% deflection	2	0.644	0.0078	2	0.655	0.0082	4	0.662	0.0013
40% deflection	2	0.700	0.0021	2	0.714	0.0094	4	0.723	0.0027
Hysteresis loop[a]	2	99.3	6.83	2	103.5	0.51	4	105.5	2.09
3rd cycle t (mm)	2	2.53	0.006	2	2.56	0.006	4	2.60	0.009
Δt (mm)[b]	2	0.120	-	2	0.081	-	4	0.081	-
Set (%)	3	18.78	5.64	3	15.19	5.02	3	15.81	2.56
Recovery (%)									
1 h	3	92.47	2.29	3	93.93	2.01	3	93.68	1.02
7 d	3	98.15	0.64	3	96.92	0.50	3	96.65	0.43
% compression for set	3	40.06	0.11	3	39.95	0.082	3	39.96	0.16

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-5. Properties of cushions from SE54 gum.

	L3223								
	TJ115EBU			TJ115EBU			TJ115ELU		
	n	av	s	n	av	s	n	av	s
Density (Mg/m^3)									
L/D disks	5	0.6544	0.0031	5	0.650	0.003	5	0.665	0.003
Set disks	3	0.6491	0.0008	3	0.6437	0.0025	3	0.6544	0.0010
3rd cycle load (kPa)									
5% deflection	3	28.7	0.24	5	34.6	0.23	5	29.7	0.54
10% deflection	3	49.3	0.50	5	58.1	0.37	5	51.1	0.78
20% deflection	3	82.7	0.69	5	95.2	0.89	5	85.3	1.38
30% deflection	3	133.0	0.88	5	154.5	1.29	5	135.9	3.24
40% deflection	3	346.1	8.80	5	386.4	6.30	5	334.9	15.5
3rd cycle unload (kPa)									
5% deflection	3	16.8	0.40	5	21.8	0.18	5	17.1	0.27
10% deflection	3	31.7	0.37	5	39.0	0.29	5	32.5	0.45
20% deflection	3	54.0	0.53	5	64.8	0.57	5	56.1	0.76
30% deflection	3	89.3	1.05	5	109.4	0.59	5	93.2	1.74
40% deflection	3	300.6	16.1	5	342.6	7.58	5	295.3	14.3
Unload/load ratio									
10% deflection	3	0.643	0.0038	5	0.672	0.0034	5	0.637	0.0072
20% deflection	3	0.653	0.0026	5	0.681	0.0026	5	0.658	0.0043
30% deflection	3	0.671	0.0049	5	0.708	0.0036	5	0.686	0.0052
40% deflection	3	0.868	0.0260	5	0.887	0.0136	5	0.882	0.0223
Hysteresis loop[a]	3	175.7	1.57	5	181.5	3.41	5	167.0	10.6
3rd cycle t (mm)	3	2.67	0.012	5	2.65	0.026	5	2.64	0.014
Δt (mm)[b]	3	0.072	0.0089	5	0.071	0.0075	5	0.067	0.0097
Set (%)	3	10.32	0.38	3	5.89	0.69	3	7.89	0.95
Recovery (%)									
1 h	3	96.36	0.14	3	97.93	0.24	3	97.24	0.33
7 d	3	97.50	0.45	3	98.72	0.21	3	98.59	0.26
% compression for set	3	35.28	0.21	3	35.06	0.92	3	35.02	0.118

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-6. Properties of cushions from SE54 gum.

	L3223					
	TJ115-2BEBU-A			TJ115-3EBU-A		
	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)						
L/D disks	5	0.6672	0.0023	5	0.6554	0.0027
Set disks	3	0.6635	0.0007	3	0.6554	0.0008
3rd cycle load (kPa)						
5% deflection	4	31.9	0.61	4	34.5	1.14
10% deflection	4	54.9	1.32	4	48.2	2.24
20% deflection	4	94.9	2.44	4	96.3	3.58
30% deflection	4	158.1	4.46	4	154.9	4.73
40% deflection	4	421.8	12.8	4	398.0	14.1
3rd cycle unload (kPa)						
5% deflection	4	18.2	0.52	4	19.6	1.08
10% deflection	4	34.9	1.04	4	36.4	1.95
20% deflection	4	62.5	1.76	4	62.1	2.83
30% deflection	4	106.8	2.82	4	103.6	3.29
40% deflection	4	354.0	8.02	4	329.7	14.4
Unload/load ratio						
10% deflection	4	0.636	0.0045	4	0.625	0.0096
20% deflection	4	0.659	0.0036	4	0.645	0.0060
30% deflection	4	0.675	0.0035	4	0.669	0.0031
40% deflection	4	0.839	0.0078	4	0.828	0.0165
Hysteresis loop[a]	4	208.4	8.88	4	215.9	5.26
3rd cycle t (mm)	4	2.64	0.029	4	2.60	0.023
Δt (mm)[b]	3	0.088	0.0089	4	0.079	0.0099
Set (%)	3	16.65	4.50	3	9.83	1.31
Recovery (%)						
1 h	3	94.18	1.56	3	96.56	0.46
7 d	3	96.39	0.88	3	97.96	0.15
% compression for set	3	34.97	0.075	3	35.01	0.055

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-7. Properties of cushions from L97KVB-0.7 gum.

	L3223-TJ150					
	EBU			-2EBU		
	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)						
L/D disks	5	0.651	0.005	5	0.6559	0.0006
Set disks	4	0.6434	0.0024	3	0.6456	0.0012
3rd cycle load (kPa)						
5% deflection	5	72.8	0.99	4	78.5	1.92
10% deflection	5	134.3	1.59	4	145.1	2.58
20% deflection	5	239.0	2.92	4	258.2	3.73
30% deflection	5	398.0	5.06	4	417.6	5.82
40% deflection	5	831.1	10.4	4	969.2	23.4
3rd cycle unload (kPa)						
5% deflection	5	55.6	2.01	4	61.0	1.88
10% deflection	5	106.3	2.52	4	115.8	2.46
20% deflection	5	186.4	2.97	4	202.7	3.57
30% deflection	5	300.6	2.68	4	333.7	6.10
40% deflection	5	763.1	13.9	4	890.7	34.4
Unload/load ratio						
10% deflection	5	0.791	0.0119	4	0.798	0.0031
20% deflection	5	0.780	0.0054	4	0.785	0.0026
30% deflection	5	0.795	0.0044	4	0.799	0.0035
40% deflection	5	0.918	0.0071	4	0.981	0.0228
Hysteresis loop[a]	5	285.2	15.6	4	314.1	4.33
3rd cycle t (mm)	5	2.67	0.030	4	2.72	0.029
Δt (mm)[b]	5	0.058	0.0168	4	0.047	0.0086
Set (%)	3	5.53	0.44	3	5.66	0.38
Recovery (%)						
1 h	3	98.06	0.16	3	98.02	0.13
7 d	3	98.54	0.16	3	98.42	0.14
% compression for set	3	35.04	0.12	3	34.98	0.023

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-8. Properties of cushions from L97KVB-0.7 gum.

	L3223-TJ150-3BEBU					
	-1			-2		
	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)						
L/D disks	2	0.6570	0.0008	5	0.6613	0.0029
Set disks	3	0.6561	0.0006	4	0.6556	0.0008
3rd cycle load (kPa)						
5% deflection	-	-	-	5	84.4	1.24
10% deflection	-	-	-	5	156.0	2.01
20% deflection	-	-	-	5	275.5	3.72
30% deflection	-	-	-	5	436.8	4.37
40% deflection	-	-	-	5	988.5	16.2
3rd cycle unload (kPa)						
5% deflection	-	-	-	5	64.0	2.13
10% deflection	-	-	-	5	123.0	3.06
20% deflection	-	-	-	5	214.5	4.42
30% deflection	-	-	-	5	345.4	5.67
40% deflection	-	-	-	5		
Unload/load ratio						
10% deflection	-	-	-	5	0.788	0.0106
20% deflection	-	-	-	5	0.778	0.0060
30% deflection	-	-	-	5	0.791	0.0058
40% deflection	-	-	-	5	0.904	0.0080
Hysteresis loop[a]	-	-	-	5	343.2	7.97
3rd cycle t (mm)	-	-	-	5	2.70	0.033
Δt (mm)[b]	-	-	-	5	0.046	0.0066
Set (%)	2	5.31	0.42	-	-	-
Recovery (%)						
1 h	2	98.14	0.16	-	-	-
7 d	2	98.33	0.23	-	-	-
% compression for set	3	35.03	0.042	-	-	-

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-9. Properties of cushions from L97KVB-0.7 gum.

	L3260-TJ150					
	EBU			-2EBU		
	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)						
L/D disks	5	0.4989	0.0019	5	0.5016	0.0135
Set disks	3	0.4948	0.0040	3	0.4981	0.0051
3rd cycle load (kPa)						
5% deflection	5	43.0	1.18	4	45.5	1.48
10% deflection	5	77.5	1.69	4	81.9	4.10
20% deflection	5	126.5	2.71	4	132.1	8.95
30% deflection	5	182.9	3.31	4	189.3	13.9
40% deflection	5	298.8	5.59	4	309.8	27.1
3rd cycle unload (kPa)						
5% deflection	5	33.7	0.89	4	35.5	1.47
10% deflection	5	62.1	1.31	4	65.4	2.99
20% deflection	5	99.7	2.11	4	103.3	6.39
30% deflection	5	144.7	2.37	4	148.9	10.3
40% deflection	5	248.7	3.92	4	257.2	22.2
Unload/load ratio						
10% deflection	5	0.802	0.0049	4	0.799	0.0088
20% deflection	5	0.788	0.0037	4	0.782	0.0066
30% deflection	5	0.791	0.0032	4	0.787	0.0054
40% deflection	5	0.832	0.0035	4	0.830	0.0031
Hysteresis loop[a]	5	189.8	9.98	4	192.8	15.9
3rd cycle t (mm)	5	2.70	0.027	4	2.65	0.015
Δt (mm)[b]	5	0.038	0.0112	4	0.043	0.0137
Set (%)	3	4.33	0.18	3	4.72	0.39
Recovery (%)						
1 h	3	98.27	0.074	3	98.13	0.18
7 d	3	98.45	0.052	3	98.62	0.13
% compression for set	3	39.96	0.059	3	40.01	0.10

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-10. Properties of cushions from L97KVB-0.7 gum.

	L3223-TJ150-3BEBU					
	-1			-2		
	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)						
L/D disks	2	0.5027	0.0018	5	0.5091	0.0015
Set disks	3	0.5025	0.0007	3	0.5047	0.0002
3rd cycle load (kPa)						
5% deflection	-	-	-	5	45.7	0.60
10% deflection	-	-	-	5	80.3	0.67
20% deflection	-	-	-	5	132.1	1.11
30% deflection	-	-	-	5	191.9	1.89
40% deflection	-	-	-	5	313.6	4.28
3rd cycle unload (kPa)						
5% deflection	-	-	-	5	34.3	0.44
10% deflection	-	-	-	5	62.7	0.61
20% deflection	-	-	-	5	102.8	1.32
30% deflection	-	-	-	5	150.4	2.87
40% deflection	-	-	-	5	262.9	3.97
Unload/load ratio						
10% deflection	-	-	-	5	0.781	0.0027
20% deflection	-	-	-	5	0.778	0.0045
30% deflection	-	-	-	5	0.788	0.0029
40% deflection	-	-	-	5	0.835	0.0035
Hysteresis loop[a]	-	-	-	5	199.3	1.41
3rd cycle t (mm)	-	-	-	5	2.66	0.020
Δt (mm)[b]	-	-	-	5	0.050	0.0175
Set (%)	2	4.90	0.21	-	-	-
Recovery (%)						
1 h	2	98.05	0.08	-	-	-
7 d	2	98.26	0.19	-	-	-
% compression for set	2	39.95	0.085	-	-	-

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-11. Properties of cushions from L97KVB-0.7 gum.

	L9755			L9760		
	TJ150-3BEBU-2			TJ150-2EBU-I		
	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)						
L/D disks	5	0.5424	0.0024	5	0.4878	0.0042
Set disks	3	0.5371	0.0003	3	0.4803	0.0033
3rd cycle load (kPa)	2	0.5354	0.0008	-	-	-
5% deflection	5	49.2	0.77	4	35.8	2.34
10% deflection	5	87.5	1.17	4	64.4	3.19
20% deflection	5	144.9	2.50	4	106.9	3.34
30% deflection	5	209.7	4.03	4	152.4	4.81
40% deflection	5	337.9	8.49	4	234.3	7.75
45% deflection	5	490.9	15.4	4	319.2	11.5
50% deflection	-	-	-	4	502.7	21.5
3rd cycle unload (kPa)						
5% deflection	5	36.7	0.69	4	27.8	1.78
10% deflection	5	68.0	1.10	4	51.2	2.35
20% deflection	5	111.4	2.08	4	83.1	2.67
30% deflection	5	160.8	3.07	4	117.1	3.92
40% deflection	5	267.3	6.47	4	182.1	6.29
45% deflection	5	408.0	11.6	-	-	-
50% deflection	-	-	-	4	432.2	20.3
Unload/load ratio						
10% deflection	5	0.777	0.0030	4	0.796	0.0059
20% deflection	5	0.769	0.0023	4	0.777	0.0063
30% deflection	5	0.767	0.0024	4	0.768	0.0049
40% deflection	5	0.791	0.0022	4	0.777	0.0055
50% deflection	-	-	-	4	0.860	0.0047
Hysteresis loop[a]	5	28.18	6.75	4	236.0	7.93
3rd cycle t (mm)	5	2.67	0.025	4	2.78	0.084
Δt (mm)[b]	5	0.046	0.0043	4	0.063	0.0094
Set (%)	2	6.23	0.47	3	6.04	0.90
Recovery (%)						
1 h	2	97.44	0.20	3	97.29	0.40
7 d	2	97.90	0.04	3	97.64	0.32
% compression for set	2	41.08	0.078	3	44.94	0.079

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-12. Properties of cushions from L97KVB-0.7 gum.

	TJ150-2EBU					
	L9765			L9770		
	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)						
L/D disks	5	0.4132	0.0046	5	0.3664	0.0029
Set disks	3	0.4118	0.0028	3	0.3751	0.0167
3rd cycle load (kPa)						
5% deflection	4	25.8	1.61	4	16.2	0.23
10% deflection	4	44.4	2.12	4	27.6	0.54
20% deflection	4	70.6	2.47	4	44.9	1.08
30% deflection	4	98.8	3.06	4	64.3	1.70
40% deflection	4	145.3	4.54	4	94.3	2.59
50% deflection	4	263.4	9.76	4	159.0	4.77
55% deflection	4	434.2	18.3	4	232.2	7.02
60% deflection	-	-	-	4	399.4	11.9
3rd cycle unload (kPa)						
5% deflection	4	19.7	1.28	4	12.2	0.25
10% deflection	4	34.8	1.57	4	21.4	0.53
20% deflection	4	54.2	1.74	4	34.2	0.99
30% deflection	4	74.9	2.19	4	47.9	1.48
40% deflection	4	110.4	3.21	4	69.5	2.15
50% deflection	4	208.7	6.84	4	117.7	3.89
55% deflection	4	377.9	14.7	4	177.0	5.95
60% deflection	-	-	-	4	335.7	11.3
Unload/load ratio						
10% deflection	4	0.783	0.0035	4	0.774	0.0041
20% deflection	4	0.767	0.0071	4	0.760	0.0042
30% deflection	4	0.758	0.0061	4	0.745	0.0035
40% deflection	4	0.760	0.0067	4	0.737	0.0031
50% deflection	4	0.792	0.0084	4	0.740	0.0031
55% deflection	4	0.871	0.0131	-	-	-
60% deflection	-	-	-	4	0.840	0.0100
Hysteresis loop[a]	4	208.1	13.9	4	194.3	8.67
3rd cycle t (mm)	4	2.73	0.040	4	2.62	0.014
Δt (mm)[b]	4	0.052	0.0152	4	0.037	0.0058
Set (%)	3	4.69	0.40	3	4.85	0.33
Recovery (%)						
1 h	3	97.65	0.19	3	97.09	0.19
7 d	3	97.90	0.22	3	97.53	0.31
% compression for set	3	50.00	0.095	3	60.04	0.050

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-13. Properties of cushions from MN97KVB-0.7 gum.

	L3223			LB3223			LBB3223		
	TJ164ELU			TJ1209811EBU			TJ1208811EBU-1		
	n	av	S.D.	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)									
L/D disks	5	0.6565	0.0016	5	0.6558	0.0041	5	0.6574	0.0020
Set disks	3	0.6572	0.0025	3	0.6553	0.0026	3	0.6547	0.0019
3rd cycle load (kPa)	-	-	-	-	-	-	-	0.6510	-
5% deflection	5	62.5	0.50	2	73.5	1.02	5	65.4	1.21
10% deflection	5	119.9	0.75	2	144.5	1.73	5	127.9	3.36
20% deflection	5	217.9	1.47	2	264.5	1.96	5	232.8	4.97
30% deflection	5	344.6	1.84	2	422.2	2.34	5	367.0	7.92
40% deflection	5	742.1	6.23	2	947.2	20.2	5	792.7	24.9
3rd cycle unload (kPa)									
5% deflection	5	48.3	0.70	2	63.3	0.66	5	58.2	2.63
10% deflection	5	96.7	0.61	2	125.3	1.56	5	112.3	2.83
20% deflection	5	173.2	1.00	2	220.1	1.70	5	196.0	4.04
30% deflection	5	274.8	2.14	2	350.9	1.58	5	308.9	6.47
40% deflection	5	647.8	15.3	2	864.6	22.5	5	732.8	29.5
Unload/load ratio									
10% deflection	5	0.806	0.0034	2	0.868	0.0004	5	0.878	0.0022
20% deflection	5	0.795	0.0024	2	0.832	0.0002	5	0.842	0.0012
30% deflection	5	0.797	0.0044	2	0.831	0.0009	5	0.842	0.0028
40% deflection	5	0.873	0.0151	2	0.913	0.0043	5	0.924	0.0118
Hysteresis loop[a]	5	273.4	18.6	2	242.4	9.67	5	196.3	21.0
3rd cycle t (mm)	5	2.72	0.015	2	2.66	0.027	5	2.71	0.020
Δt (mm)[b]	5	0.031	0.0155	2	0.029	0.0038	5	0.039	0.0132
Set (%)	3	5.91	0.70	3	6.07	0.31	1	5.31	-
Recovery (%)									
1 h	3	97.92	0.61	3	97.88	0.11	1	98.14	-
7 d	3	98.11	0.093	3	98.70	0.19	1	98.51	-
% compression for set	3	34.99	0.075	3	34.95	0.071	1	34.94	-

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-14. Properties of cushions from MN97KVB-0.7 gum.

	L3260 TJ175ELU			LB9775 TJ1209811EBU			LBB9755 TJ1208811EBU-1		
	n	av	S.D.	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)									
L/D disks	5	0.5226	0.0052	5	0.5268	0.0013	5	0.5358	0.0075
Set disks	3	0.5205	0.0046	3	0.5283	0.0049	4	0.5340	0.0095
3rd cycle load (kPa)	-	-	-	-	-	-	2	0.5275	0.0012
5% deflection	5	34.8	0.63	4	36.1	0.36	5	31.7	0.64
10% deflection	5	63.5	1.23	4	66.2	0.67	5	59.8	1.47
20% deflection	5	108.5	2.94	4	113.3	1.35	5	104.9	4.17
30% deflection	5	161.1	4.88	4	167.5	1.64	5	155.6	7.52
40% deflection	5	266.3	9.77	4	273.0	2.61	5	251.2	15.0
45% deflection	-	-	-	-	-	-	5	357.8	-
50% deflection	-	-	-	2	701.6	3.54	5	613.7	59.1
3rd cycle unload (kPa)									
5% deflection	4	29.5	0.62	4	30.3	0.32	5	26.3	0.98
10% deflection	4	54.5	1.14	4	56.2	0.77	5	50.8	0.61
20% deflection	4	91.0	2.86	4	93.8	1.28	5	87.4	2.44
30% deflection	4	134.3	4.85	4	137.1	1.47	5	128.5	4.94
40% deflection	4	229.7	10.6	4	226.7	2.18	5	210.7	11.0
50% deflection	-	-	-	2	701.6	3.54	5	613.7	59.1
Unload/load ratio									
10% deflection	4	0.854	0.0036	4	0.849	0.0031	5	0.849	0.0167
20% deflection	4	0.837	0.0030	4	0.828	0.0015	5	0.833	0.0103
30% deflection	4	0.832	0.0022	4	0.818	0.0013	5	0.826	0.0084
40% deflection	4	0.860	0.0041	4	0.830	0.0022	5	0.839	0.069
Hysteresis loop[a]	4	127.6	9.52	4	167.6	9.14	5	159.0	22.7
3rd cycle t (mm)	4	2.68	0.004	4	2.66	0.025	5	2.62	0.025
Δt (mm)[b]	4	0.033	0.0036	4	0.034	0.0041	5	0.025	0.0036
Set (%)	3	4.59	0.68	3	5.60	0.46	2	5.41	0.35
Recovery (%)									
1 h	3	98.31	0.41	3	97.70	0.18	2	98.35	0.07
7 d	3	98.29	0.18	3	98.27	0.18	2	91.31	0.06
% compression for set	3	40.46	0.39	3	41.06	0.075	2	41.03	0.007

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-15. Properties of cushions from MN97KVB-0.7 gum.

	TJ120981lEBU-1								
	LB9750			LB9760			LB9770		
	n	av	S.D.	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)									
L/D disks	5	0.5837	0.0017	5	0.4767	0.0015	5	0.3388	0.0019
Set disks	3	0.5828	0.0007	3	0.4715	0.0047	3	0.3362	0.0016
3rd cycle load (kPa)	2	0.5818	0.0006	-	-	-	2	0.3355	0.0023
5% deflection	5	44.9	1.41	2	26.6	0.34	5	12.1	0.27
10% deflection	5	85.1	2.21	2	47.4	0.10	5	20.8	0.41
20% deflection	5	149.4	3.69	2	79.3	0.22	5	33.2	0.59
30% deflection	5	223.9	4.39	2	114.5	1.31	5	45.7	0.82
40% deflection	5	385.3	6.19	2	176.2	3.87	5	63.8	1.16
45% deflection	5	621.9	14.4	2	237.0	6.47	-	-	-
50% deflection	-	-	-	2	362.1	12.2	5	99.7	1.96
60% deflection	-	-	-	-	-	-	5	219.5	5.24
3rd cycle unload (kPa)									
5% deflection	5	38.5	1.33	2	22.0	0.018	5	10.2	0.25
10% deflection	5	73.7	2.19	2	39.8	0.31	5	17.7	0.35
20% deflection	5	125.4	3.47	2	65.1	0.18	5	27.5	0.49
30% deflection	5	186.9	3.86	2	92.8	0.64	5	37.2	0.66
40% deflection	5	333.4	5.34	2	143.8	2.65	5	51.5	0.92
45% deflection	5	584.3	16.3	-	-	-	-	-	-
50% deflection	-	-	-	2	319.1	8.40	5	81.1	1.55
60% deflection	-	-	-	-	-	-	5	195.7	4.84
Unload/load ratio									
10% deflection	5	0.866	0.0038	4	0.839	0.0083	5	0.848	0.0018
20% deflection	5	0.840	0.0028	4	0.821	0.0046	5	0.828	0.0012
30% deflection	5	0.835	0.0015	4	0.811	0.0036	5	0.815	0.0012
40% deflection	5	0.865	0.0024	4	0.816	0.0029	5	0.808	0.0009
45% deflection	5	0.939	0.0045	-	-	-	-	-	-
50% deflection	-	-	-	2	0.881	0.0065	5	0.814	0.0010
60% deflection	-	-	-	-	-	-	5	0.892	0.0010
Hysteresis loop[a]	5	162.1	9.28	2	145.3	19.1	5	88.1	2.55
3rd cycle t (mm)	5	2.68	0.033	2	2.63	0.051	5	2.79	0.046
Δt (mm)[b]	5	0.027	0.0124	2	0.039	0.0117	5	0.021	0.0038
Set (%)	2	4.95	0.16	3	4.27	0.18	2	8.78	0.43
Recovery (%)									
1 h	2	98.15	0.06	3	98.08	0.08	2	94.74	0.26
7 d	2	98.67	0.23	3	98.66	0.015	2	96.71	0.13
% compression for set	2	37.45	0.014	3	45.04	0.076	2	60.00	0.071

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-16. Properties of cushions from L60VB-0.7 gum.

	TJ154EBU					
	L3223			L3260		
	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)						
L/D disks	5	0.6466	0.0020	5	0.5027	0.0026
Set disks	3	0.6442	0.0040	3	0.5129	0.0182
3rd cycle load (kPa)						
5% deflection	5	60.5	2.85	5	33.5	0.68
10% deflection	5	116.4	5.57	5	60.8	1.60
20% deflection	5	209.4	10.8	5	101.5	3.03
30% deflection	5	329.8	17.7	5	145.5	4.77
40% deflection	5	703.1	43.4	5	229.1	9.49
3rd cycle unload (kPa)						
5% deflection	5	50.9	2.47	5	28.7	0.40
10% deflection	5	100.7	5.26	5	52.9	0.89
20% deflection	5	176.2	9.39	5	86.5	1.86
30% deflection	5	275.5	15.1	5	123.2	3.22
40% deflection	5	639.8	40.9	5	198.7	7.47
Unload/load ratio						
10% deflection	5	0.864	0.0044	5	0.869	0.0101
20% deflection	5	0.842	0.0022	5	0.852	0.0076
30% deflection	5	0.835	0.0026	5	0.846	0.0062
40% deflection	5	0.910	0.0051	5	0.867	0.0083
Hysteresis loop[a]	5	198.1	13.8	5	112.8	12.8
3rd cycle t (mm)	5	2.73	0.022	5	2.66	0.010
Δt (mm)[b]	5	0.041	0.0061	5	0.031	0.009
Set (%)	3	3.84	0.29	3	3.30	0.63
Recovery (%)						
1 h	3	98.65	0.10	3	98.68	0.25
7 d	3	98.78	0.18	3	98.90	0.046
% compression for set	3	35.03	0.13	3	39.99	0.12

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-17. Properties of cushions from L60VB-0.7 gum.

	L6050						L6055		
	TJ154EBU-1			TJ154EBU repeat-1			TJ154EBU-1		
	n	av	S.D.	*n*	av	S.D.	*n*	av	S.D.
Density (Mg/m^3)									
L/D disks	5	0.5827	0.0012	5	0.5784	0.0016	5	0.5293	0.0016
Set disks	-	-	-	3	0.5763	0.0018	-	-	-
3rd cycle load (kPa)	-	-	-	2	0.5767	0.0003	-	-	-
5% deflection	5	49.8	0.98	5	45.4	0.54	2	34.1	0.19
10% deflection	5	94.8	1.69	5	86.1	1.33	2	62.9	0.64
20% deflection	5	167.2	3.38	5	150.1	2.53	2	107.7	1.22
30% deflection	5	252.2	4.20	5	222.6	4.62	2	158.2	1.89
40% deflection	5	444.6	5.10	5	381.3	11.9	2	254.3	3.06
45% deflection	5	744.9	7.68	5	615.9	23.3	2	362.5	4.14
3rd cycle unload (kPa)									
5% deflection	5	42.3	0.90	5	40.4	0.75	2	29.2	0.13
10% deflection	5	82.4	1.65	5	77.3	1.32	2	54.6	0.52
20% deflection	5	141.8	3.21	5	130.8	2.38	2	91.5	0.98
30% deflection	5	212.5	4.00	5	192.2	4.13	2	133.2	1.44
40% deflection	5	388.0	5.41	5	338.8	11.3	2	217.2	2.42
45% deflection	5	703.8	10.9	5	587.7	26.9	2	319.0	3.00
Unload/load ratio									
10% deflection	5	0.869	0.0020	5	0.898	0.0030	2	0.868	0.0006
20% deflection	5	0.848	0.0022	5	0.872	0.0027	2	0.850	0.0005
30% deflection	5	0.843	0.0019	5	0.863	0.0018	2	0.841	0.0009
40% deflection	5	0.873	0.0029	5	0.888	0.0025	2	0.854	0.0007
Hysteresis loop[a]	5	180.8	11.3	5	136.4	8.82	3	134.3	7.83
3rd cycle t (mm)	5	2.68	0.019	5	2.69	0.030	3	2.66	0.008
Δt (mm)[b]	5	0.029	0.0069	5	0.025	0.0066	3	0.024	0.0041
Set (%)	-	-	-	2	4.41	0.018	-	-	-
Recovery (%)									
1 h	-	-	-	2	98.35	0.07	-	-	-
7 d	-	-	-	2	98.68	0.13	-	-	-
% compression for set	-	-	-	2	37.43	0.042	-	-	-

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

Table A-18. Properties of cushions from L60VB-0.7 gum.

	L6060			L6065			L6070		
	TJ154EBU-1			TJ154EBU-II			TJ154EBU-1		
	n	av	S.D.	n	av	S.D.	n	av	S.D.
Density (Mg/m^3)									
L/D disks	5	0.4630	0.0039	5	0.4141	0.0073	5	0.3383	0.0026
Set disks	3	0.4572	0.0042	3	0.4154	0.0090	-	-	-
3rd cycle load (kPa)									
5% deflection	3	26.0	0.64	2	17.0	3.00	5	11.4	0.26
10% deflection	3	48.1	0.61	2	33.4	2.36	5	19.9	0.32
20% deflection	3	79.9	1.34	2	57.8	0.90	5	32.2	0.44
30% deflection	3	112.9	2.31	2	82.6	3.20	5	45.1	0.63
40% deflection	3	169.7	4.19	2	122.0	5.94	5	63.9	0.96
45% deflection	3	224.8	-	-	-	-	-	-	-
50% deflection	3	333.4	12.0	2	217.9	13.1	5	101.3	1.83
55% deflection	-	-	-	2	351.2	26.4	-	-	-
60% deflection	-	-	-	-	-	-	5	230.0	4.72
3rd cycle unload (kPa)									
5% deflection	3	23.0	0.61	2	14.1	2.69	5	9.50	0.19
10% deflection	3	42.7	0.50	2	28.5	1.90	5	16.8	0.26
20% deflection	3	69.0	1.23	2	48.4	1.29	5	26.7	0.32
30% deflection	3	95.6	2.14	2	68.1	3.35	5	26.9	0.42
40% deflection	3	143.7	3.86	2	100.1	5.96	5	52.0	0.68
45% deflection	3	298.7	10.3	2	184.1	13.4	5	83.2	1.42
55% deflection	-	-	-	2	318.5	29.6	-	-	-
60% deflection	-	-	-	-	-	-	5	207.0	4.94
Unload/load ratio									
10% deflection	3	0.888	0.0010	2	0.855	0.0035	5	0.843	0.0030
20% deflection	3	0.863	0.0011	2	0.838	0.0093	5	0.829	0.0023
30% deflection	3	0.847	0.0017	2	0.824	0.0087	5	0.818	0.0025
40% deflection	3	0.846	0.0020	2	0.820	0.0089	5	0.814	0.0029
50% deflection	3	0.896	0.0023	2	0.845	0.0107	5	0.821	0.0029
Hysteresis loop[a]	3	112.7	8.76	2	123.5	10.4	5	85.8	5.13
3rd cycle t (mm)	3	2.65	0.037	2	2.70	0.086	5	2.67	0.038
Δt (mm)[b]	3	0.031	0.0066	2	0.070	0.0345	5	0.023	0.0021
Set (%)	3	5.14	0.25	3	4.96	0.26	-	-	-
Recovery (%)									
1 h	3	97.68	0.11	3	97.52	0.12	-	-	-
7 d	3	98.10	0.10	3	97.93	0.24	-	-	-
% compression for set	3	45.01	0.032	3	50.03	0.040	-	-	-

[a] Difference between 3rd cycle load and unload curves.
[b] Difference between 1st and 3rd cycle starting thickness.

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