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The Effects of Specific Gravity in Contact Lens Movement

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Abstract: The movement of rigid contact lenses ~~within~~ the eye are investigated using specially designed lenses of PMMA and ~~silicone acrylate~~ material. The lenses were designed to be identical in all parameters except weight. This study indicates that the weight of the lenses as determined by the specific gravity of its material does not play a major role in the lens decentration in a properly fitted lens.

Purpose

Since the introduction of gas permiable rigid contact lenses todays practioners have been bombarded with manufacturers claims that their lenses are the most comfortable that is available because of each ones design, material or coatings. This study was designed to study both a lens' "sag" movement (the extent of slippage of a contact lens in primary position) and vertical "lag" movement (the extent of slippage involved with an eye movement away from primary position). Theoretically if a lens moves too much on the cornea a patient will notice increased discomfort.

Some of the factors leading to excessive sag movements are the base curve being fit too flat, a lens fit with a overall diameter that is too small, or simply a heavy lens. A heavy contact lens can come about in the same way as a heavy spectacle lens, its actual parameters (overall diameter, thickness, etc) or the weight of it's material (specific gravity). This study has been designed to investigate the involvement of specific gravity in contact lens movements.

Materials and Methods

Contact lenses were manufactured from two materials polymethylmethacrylate (PMMA) and silicone acrylate (Opus III™) material in identical parameters. The lenses were ordered through the same lab in an attempt to reduce any machining differences.

The parameters used in the study (both PMMA and Opus III) are shown in table 1. The 8.0 mm overall diameter was chosen in all but the fourth lens in each set in an attempt to reduce the involvement of lid forces. Thickness is the only parameter changed in each series of lenses to change the volume of each and subsequently the weight. Base curves, secondary curves and tertiary curves are unchanged throughout each series as a constant.

The weight of each lens was determined by a computer program designed by Gerald E. Lowther, O.D., Ph.D. at Ferris State College School of Optometry, which calculates a contact lens volume. The volume multiplied by the manufacturers reported specific gravity yields the weight.

Six previous rigid contact lens wearers were fit with each lens in a series. The lenes movements were photorecorded using a RCA 2000 videocamera, a Hitachi videotuner and 3 head portable video cassette recorder. The view was magnified 7x using a Nikon slitlamp. This enabled the sag and lag movements to be measured accurately at a later time by measuring a grid on the video monitor during playback. The patients were asked to view directly ahead, then look at a fixation target approximately 35° up. Three of these movements were recorded then averaged.

Results

The results are shown in figures 1 through 12. Each of the twelve graphs correspond to the movements of the contact lens on an individual eye. The movements shown represent the total decentration of the lens by adding the sag and lag measurements together. The PMMA lenses increase in decentration from the .10 to the .15 center thickness lenses in only 5 of 12 eyes. In comparison the Opus III lenses increase in 8 of 12 eyes. The lenses of .15 center thickness to .20 the PMMA lenses increase in 9 of 12 eyes and in 10 of 12 for the Opus III. The other trend is for a decrease in 8 of 12 of the PMMA lenses in the 9.5 diameter lens. Eleven of 12 decrease in decentration for the Opus III lenses.

The average of all 12 eyes are graphed in figure 13. The PMMA lenses show greater or equal decentration in all four lens designs. In figure 14 the two pair of eyes that were fit over 2.00 diopters too flat were separated from the others (the eyes from figures 1, 2, 5 and 6).

Conclusion

The twelve graphs show that there is a consistant pattern to the movements of the contact lenses in each series, although the values for PMMA are not consistantly higher than those of Opus III material as would be expected from the values for the contact len's weight. This fact is also mirrored in the nearly identical values for both PMMA and Opus III in the graph of average values.

Figure 14 indicates that there is a much greater decentration value amoung the flat fitting lenses. It appears that the weight of the lenses play a greater role on poorly fit lenses, on properly fit lenses the weight of the lens, as a result of its specific gravity, plays only a small role in comparison to other forces in play in the eye.

Acknowlegment

We wish to thank the Precision-Cosmet Company, Inc. for furnishing the Opus III and PMMA lenses used in this study.

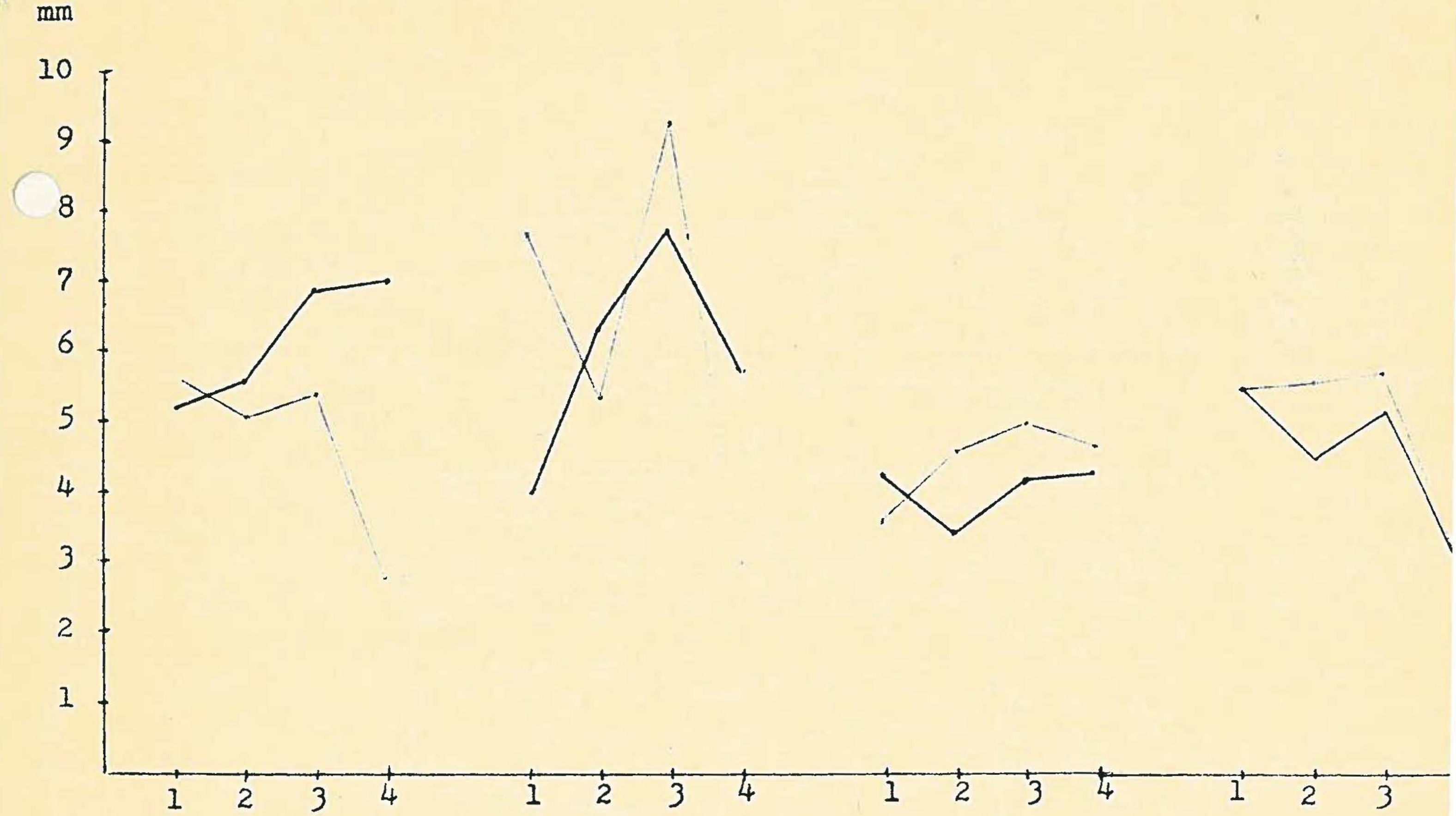

figure 1 figure 2 figure 3 figure 4

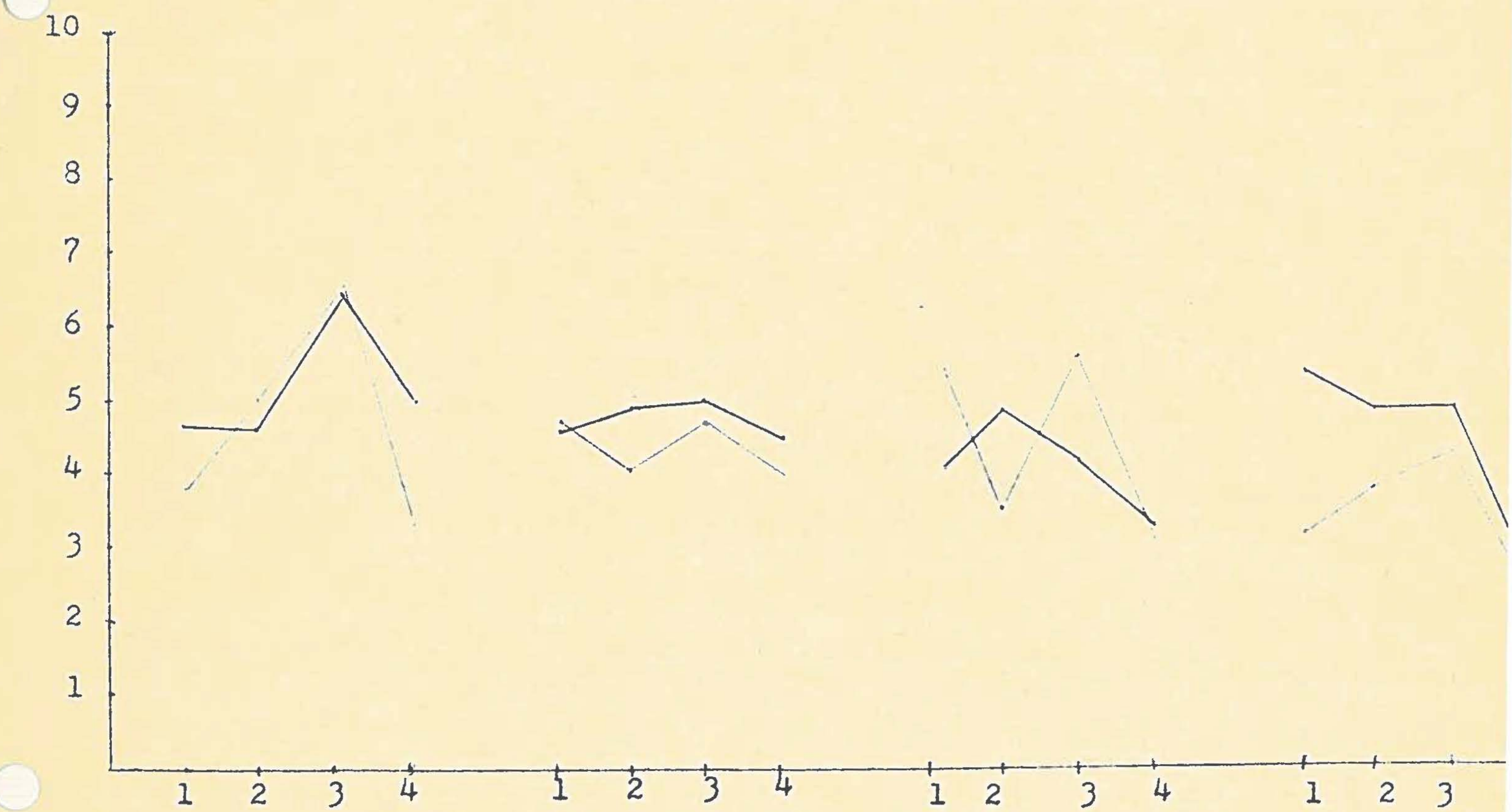

figure 5 figure 6 figure 7 figure 8

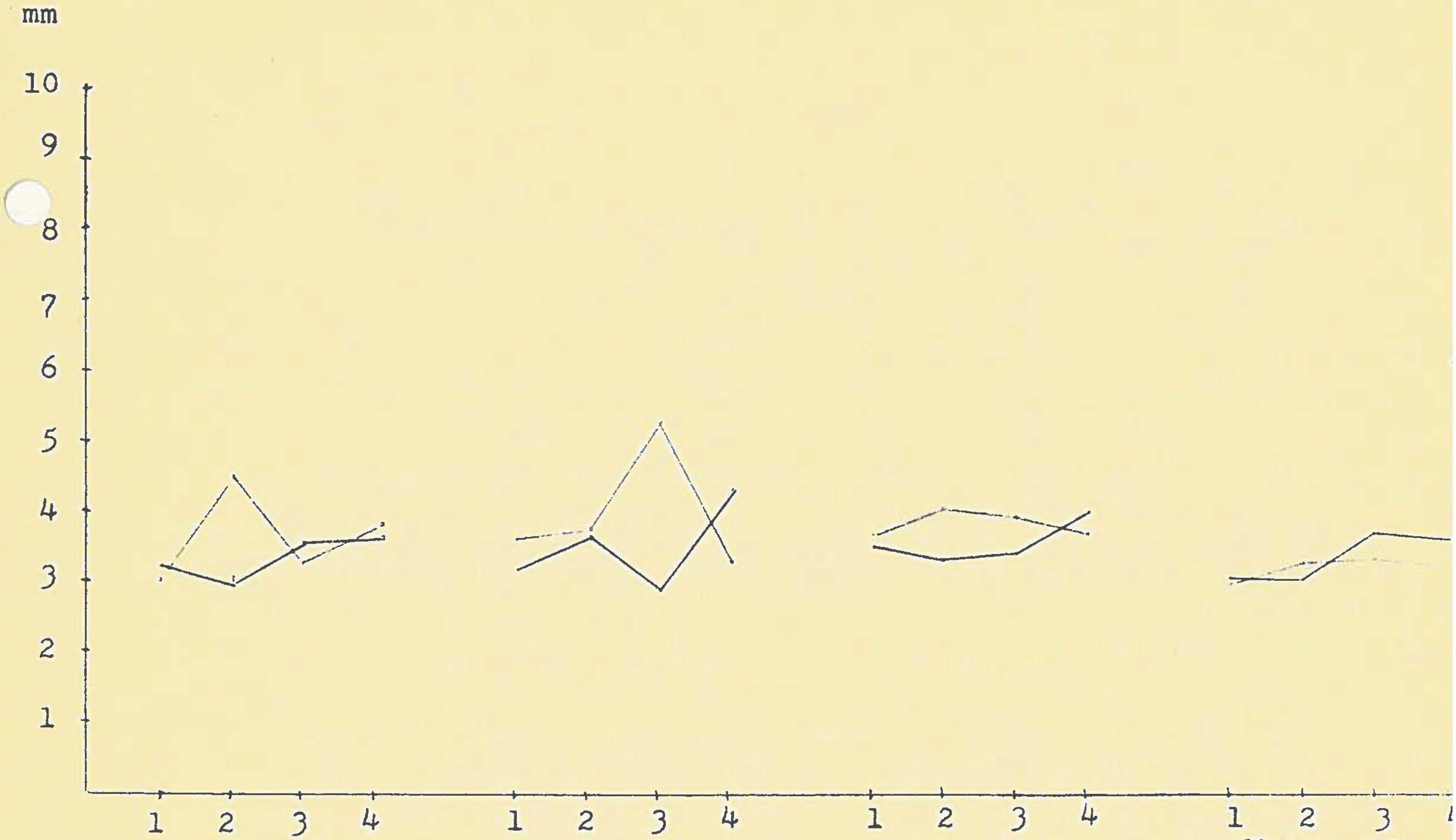

figure 9 figure 10 figure 11 figure 12

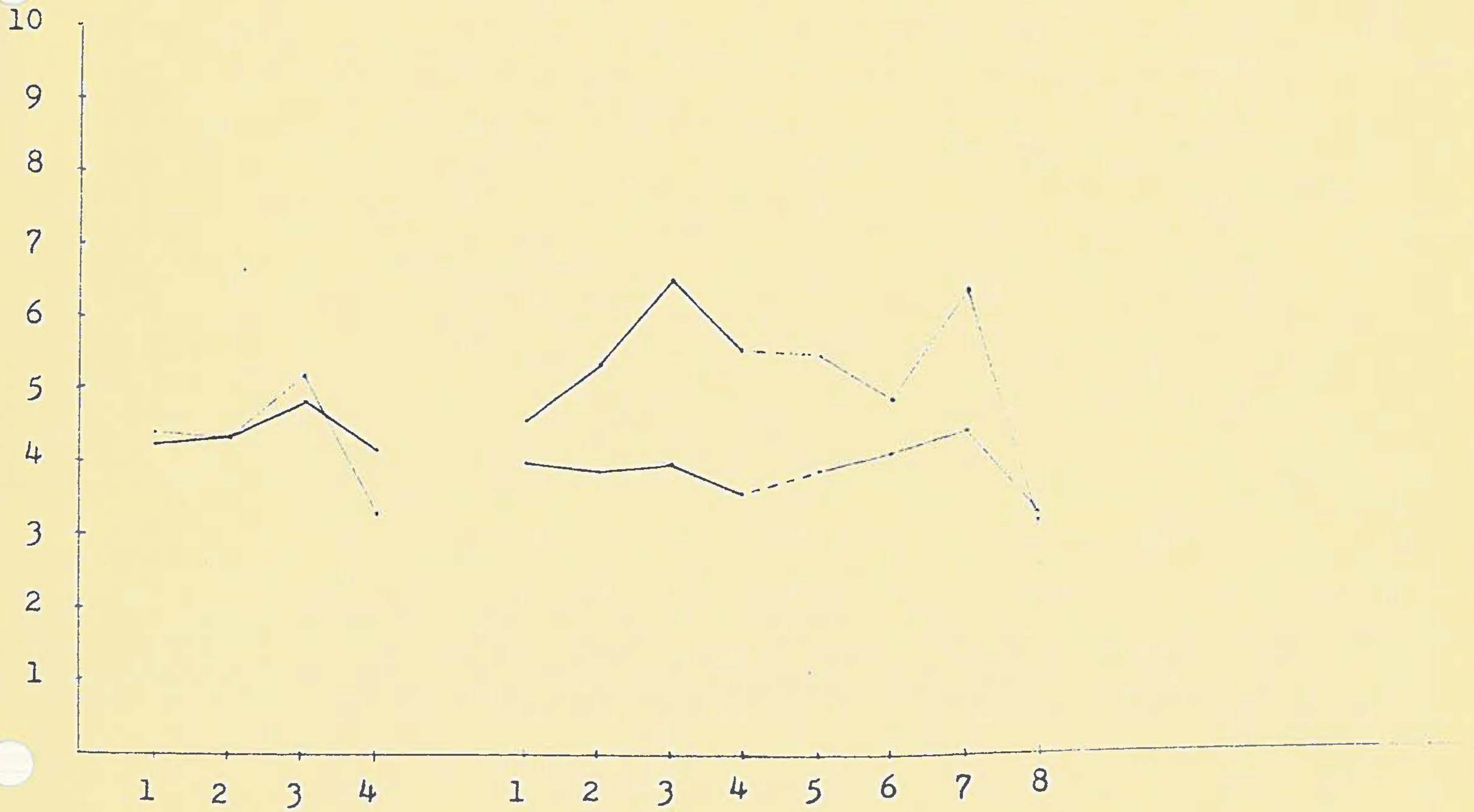

figure 13 figure 14

BC	Power	OAD	2° Curve	W	3° Curve	W	Peripheral Curve	W	OZ	CT	PMMA wt.mg	Opus III wt. mg
7.54	-3.00	8.1	8.54	2	9.54	2	10.54	3	6.7	.10	10.50	8.85
7.54	-3.00	8.1	8.54	2	9.54	2	10.54	3	6.7	.15	13.14	11.53
7.54	-3.00	8.1	8.54	2	9.54	2	1o.54	3	6.7	.20	16.78	14.21
7.60	-3.00	9.5	8.60	2	9.60	2	10.60	2	8.3	.10	18.81	15.84
7.85	-3.00	8.1	8.85	2	9.85	2	10.85	3	6.7	.10	10.32	8.69
7.85	-3.00	8.1	8.85	2	9.85	2	10.85	3	6.7	.15	13.45	11.37
7.85	-3.00	8.1	8.85	2	9.85	2	10.85	3	6.7	.20	16.58	14.05
7.95	-3.00	9.5	8.95	2	9.95	2	10.95	2	8.3	.10	18.22	15.33

Table 1

→ fit for offset

18.5	4.63
21.56	5.39
26.24	6.56
22.5	5.58
21.75	5.44
19.34	4.84
25.88	6.47
12.95	3.23

4.03
3.84
4.00
3.59
3.90
4.12
4.57
3.34

Proper fits on K.

LAG + SAG

11	12	21	22	31	32	
5.25	4	4.33	5.5	4.67	4.58	
5.58	6.42	3.5	4.5	4.65	4.91	
6.91	7.83	4.21	5.17	6.50	5.00	35.62
7.00	5.75	4.33	3	5.05	4.50	27.63
5.58	7.63	3.75	5.50	3.83	4.71	31.01
5.00	5.33	4.58	5.64	5.0	4.01	29.30
5.33	9.25	5.08	5.75	6.58	4.79	30.7[illegible]
2.67	2.91	4.46	3	3.33	4.04	30.41

PMMA

Averages	41	42	51	52	61	62
4.23	4.08	5.33	3.25	3.19	3.5	3.08
4.36	4.88	4.84	3.0	3.67	3.33	3.05
4.85	4.17	4.84	3.58	2.92	3.42	3.75
4.25	3.25	2.50	3.67	4.33	4.01	3.69
4.41	5.41	3.13	3.08	3.59	3.67	3
4.36	3.50	3.75	4.5	3.75	4.08	3.25
5.20	5.58	4.23	3.25	5.33	3.92	3.33
3.31	3.08	2.25	3.83	3.21	3.71	3.33

PMMA

a. simple myopic astigmatism

SAG

11	12	21	22	31	32
1.75	1.25	3.17	3.5	2.25	3.33
2.5	3.67	3	3.5	1.9	3.33
2.58	4.33	3.33	3.5	3	3.5
3.67	2.5	3.33	3	3.38	2.83
2.00	3.88	3	2.67	2.83	3.33
1.50	1.83	3	3.33	2.5	3.13
1.33	4.33	3.33	3.33	3.33	3.87
2.33	2.33	2.83	3	2.16	2.66

41	42	51	52	61	62
3.08	2	3.25	3	3	2.75
3	2.17	3	3	2.83	2.63
3	2.17	3	2.5	3	3
2.75	2.25	3.5	4	3.63	3.25
2.83	1.5	2.5	2.67	3.42	3
1.67	1.58	3.5	2.75	3.5	3
4	2.17	2.25	2.58	3.42	3.33
2.83	2.17	3.25	2.58	3.38	3

LAG

11	12	21	22	31	32
3.5	2.75	1.16	2.00	2.42	1.25
3.08	2.75	.5	1.00	2.75	1.58
4.33	3.50	.88	1.67	3.50	1.50
3.33	3.25	1.0	0	1.67	1.67
3.58	3.75	.75	2.83	1.00	1.38
3.50	3.50	1.58	2.31	2.5	.88
4.00	4.92	1.75	2.42	3.25	.92
.33	.58	1.63	0	1.17	1.38

41	42	51	52	61	62
1.0	3.33	0	.19	.5	.33
1.88	2.67	0	.67	.5	.42
1.17	2.67	.58	.42	.42	.75
.5	.25	.17	.33	.38	.44
2.58	1.63	.58	.92	.25	0
1.83	2.17	1.0	1.0	.58	.25
1.58	2.06	1.0	1.75	.50	0
.25	.08	.58	.63	.33	.33