The AK Block, a Sized-Block Snow Test

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ABSTRACT: The AK Block is a snow test developed and used by the Southeast Alaska Avalanche Center staff over a 20-year period. It is a block sized to the tester's weight and their ski or snowboard contact length, dug out on three sides. It is loaded in the same manner as the Rutschblock, but tests slab properties as well as shear strength. The AK Block can be done quickly by one person using a shovel, a tool to lay out the tester's block width and length (tape, rule, or marked probe, cord, ski, snowboard, or pole), and skis or a board to load the block. It has a large sample area and gives direct sensory feedback. The sized block may allow direct comparison between blocks by testers of different weights. The first systematic testing of the AK Block, in the Chugach Mountains near Valdez, Alaska in the 2002 - 2003 winter and in the Coast Mountains near Juneau, Alaska in the 2003 - 2004 winter, is reported here. An unusually strong snowpack limited our data sample, so this is a preliminary report. The initial results are promising though, and we are recruiting other workers to help us gather more data.

Keywords: avalanche, snow stability tests, block tests, sized-block, AK Block, Rutschblock

1. Introduction

A number of tests have been developed by avalanche workers over the years as tools to help them evaluate snow stability. While the usefulness of extrapolation from any snow tests is limited by the spatial variability of the snowpack, fieldworkers and recreationists still find snow tests to be a valuable tool, particularly when used as part of a targeted search for instability, as noted by Landry (2002) and Mc Clung (2002).

Most field workers favor small block, or column, tests for their speed, but their results are easily skewed by small scale spatial variability.

The Rutschblock is widely regarded as the standard against which other snow tests are measured, but it is seldom used in the field, especially by recreationists. The large block takes more time and effort to dig out, and cutting the back can be problematic. Cutting with a cord requires two people and we find that it almost always results in a bow-shaped cut that is not deep enough in the middle. Good saws cut cleanly, but few easily portable saws can cut to the required depth in all snow conditions.

Yet the Rutschblock and other similar large block tests have distinct advantages. Their large sample area helps average out small-scale spatial variability, as noted in Schweizer (2004), and there is evidence from psychological studies, as summarized in Gonzales (2003) and Goleman (1995), that such gut-level feedback as feeling the block give way underfoot more effectively influences decisionmaking than abstract feedback like that of the small block tests does.

Over twenty years ago, the author and the Southeast Alaska Avalanche Center staff began experimenting to find large block tests that could be set up more easily and quickly than Rutschblocks. We found that we got consistent results when the tester's skis or snowboard spanned the entire back of the block, effectively cutting it in much the same way that a skier or boarder cuts a slab loose underfoot.

Until 2003 - 2004, we used a block width (across the slope) equal to the contact length of the tester's skis or board, and a height (on the fallline of the slope) of 1.50 m for all testers. This block size worked well for our typical tester, and it was easy to dig. Our experience was that it was reliable in everyday use, but we did not have an opportunity to do systematic testing until the winters of 2002 - 2003 and 2003 - 2004.

The results from the first winter were promising, but showed us that the blocks need to be sized to tester weight by adjusting block height as well as sizing width to ski or board contact length, so the

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second winter's study focused on evaluating the effect of block sizing on test values.

Unusually strong snowpack conditions during our study period did not give us the full range of test values we needed, so these are preliminary findings, pending collection of a more complete data set. We invite other workers to help us collect additional test results. Data from a variety of snow climates would be especially useful.

2.1 Methods, 2002 - 2003 Season

Fieldwork was conducted in the Chugach Range near Valdez, Alaska in March and April 2003. Sites were reached by a combination of helicopter, snowshoeing, and climbing with skins on skis or splitboards.

Sites were chosen to maximize uniformity of slope and loading. Slopes steep enough to slide were chosen, with 38° to 45° angles preferred where possible. The Thompson Pass area permitted sampling in a variety of snow climates.

Where possible, sites with one principal weak layer were chosen. At sites with multiple weak layers, only the test values for fractures on the principal common layer were used for test block comparison. Data from any other layers that fractured was not used.

The block arrays were laid out so tests alternated sides to eliminate aspect effects. Each site had one AK Block, one Rutschblock, two tap compression tests, and two stuffblock tests. All shared common edges to minimize spatial variability. If vegetation, rocks, drifts, or other compromising factors were encountered, the affected tests were repeated in a spot more representative of the site.

A detailed snow profile, including temperature and density measurements, was made to well beyond the depth of the weak layer at each site.

Blocks were laid out for our study using graduated avalanche probes and folding rules to ensure precise size and shape. All blocks were cut with a two-piece 1.30 m Rutschblock saw before being dug out.

All field methods were consistent with the American Avalanche Association (AAA) observation guidelines, as outlined in American Avalanche Association (2004).

Figure 1. Coleen Harrier digging out a block pair after laying and sawing them out, Valdez.

The AK Block width (across the slope) in both seasons was the contact length of the skis or snowboard ridden by the tester. The contact length for snow test purposes is longer than that measured on a hard bench. The ski or board cuts into even the hardest snow, so the length can include the first 0.003 m (3 mm) of rise in the nose or tail. The contact length is rounded to the nearest 0.05 m (5cm) to determine block size.

All AK Blocks in the 2002-2003 tests used a block height (on the fallline of the slope) of 1.50 m (150 cm), regardless of tester weight.

Block depth was at least 0.10 m (10 cm) beyond the weak layer being tested.

AK Block loading steps followed the AAA guidelines for the Rutschblock. Both skis and snowboards were used in 2002 – 2003. All loads were applied with skis or boards attached. Testers remained on the block, without flying leaps from above. The loading steps used are summarized here:

1 fails during setup
2 on approach or gently moving onto block
3 on knee flex
4 on first gentle jump
5 on second hard jump
6 on three or more jumps
7 no failure

Shear quality was noted for all tests.

Figure 2. Coleen Harrier and John Bressette jumping on adjacent blocks, Valdez. Snowboards and skis were used interchangeably in 2002 – 2003. No difference was noted, but skis only were used starting in 2003 – 2004 to eliminate the possibility of introducing another variable.

2.2 Results and Conclusions, 2002 - 2003 Season

We tested 17 sites in 2002 - 2003. Slope angles ranged from 33° to 48°, averaging 40°. Weak layer depth ranged from 0.21 to 1.46 m, averaging 0.65 m. Tester weight ranged from 50 to 93 Kg, averaging 74 Kg.

Conclusions for this first season are noted along with results because what we learned caused us to modify the following year's studies.

AK Block test values were consistent with Rutschblock results, the difference averaging 0.35 step higher, less than half a step. Only 22 percent of the Rutschblocks fractured at the cut.

These results suggest that cutting the back of test blocks sized to contact length is not significant. This is particularly surprising given that the snowpack had some very hard buried windslabs from several weeks of winds in the 30+ m/sec range prior to the test period, exactly the conditions where intuition suggests that the cut would be most important.

Tester weight proved to be a far more important factor than the back cut. In the strong snowpack we had, many blocks that would not fracture under a light tester would fracture under a heavier one. To evaluate the effect, we departed from normal block test procedure and had a heavier tester load any block that did not fracture under our lightest tester. In the 13 tests where this was done, increased tester weight produced fracture 69 percent of the time. It was obvious that we had to control for tester weight.

The clue that block size was the other key variable came when small block tests fractured within their normal test value range even when our initial Rutschblock value was 7, or no failure, in 55 percent of these cases.

3.1 Methods, 2003 - 2004 Season

Fieldwork was conducted in the Coast Range near Juneau, Alaska in December through May 2003 - 2004. Sites were reached by a combination of helicopter and skinning on skis or splitboards.

We sampled in a variety of snow climates, but an early spring produced more uniformity in the regional snowpack than we had hoped for.

Most test procedures were unchanged from 2002 - 2003, but we focused on testing sized blocks, and we streamlined field procedures so we could gather a larger data set.

To speed fieldwork, only one snow profile was done daily, to generally characterize each day's snowpack, slab, and weak layer, rather than to document each site in detail. The tap compression and stuffblock tests were dropped.

At each site, we cut and dug an array of side-by-side paired Rutschblocks and AK blocks. The team worked upslope so the untested snow was not disturbed.

We used one tester at each site to load AK Blocks of varying size to determine whether increasing or decreasing block size results in the hypothesized linearly proportional changes in test values.

Though no difference in loading with skis or snowboards was detected in the first season, we limited loading to skis only in 2003 – 2004 to eliminate a potential variable.

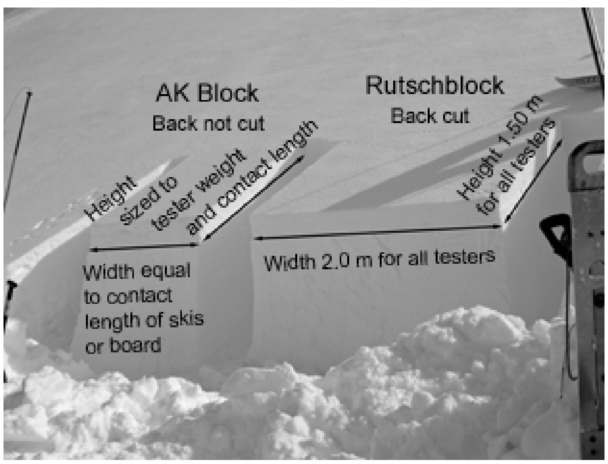

Figure 3. Paired AK Block and Rutschblock showing layout, Juneau.

We developed a sizing table (Table 1) that varies the block area by the same percentage as the departure from an arbitrary zero at 90 Kg, our most common staffer weight.

The weight used for block sizing is tester weight in the morning without clothing or gear. While it would be more precise to use weight with field clothing and gear, few avalanche workers and almost no recreationists know their field weight.

The AK Block is intended first of all as a test for the lay public, so it must be as user friendly as possible. While a correction could be introduced for heavier or lighter gear and clothing, and will be if it proves necessary, the results so far suggest that the variability introduced by clothing and gear weight may be below the limit of detection.

We unsuccessfully tried calibrating the AK Block to the same 80 Kg field tester weight with clothing and gear that was used for the Rutschblock. A tester weighing 80 Kg in the field weighs about 65 Kg without clothing and gear. When we sized the AK Block so it gave the same test value as a Rutschblock with so light a tester, it made most testers' AK Block size much too large for practical digging.

Each AK Block was paired with an adjacent Rutschblock to control for spatial variability. The AK Block and Rutschblock sides were traded for every pair to eliminate aspect effects.

In addition to the big 1.30 m Rutschblock saw, we used a light, compact but strong 1.00 m RB 100 saw with a Life Link shovel handle inserted into its handle for cutting leverage on full-depth cuts.

3.2 Results, 2003 - 2004 Season

We used results from ten sites in 2003 - 2004. Data from one other site had to be discarded due to fracture on different weak layers. Slope angles ranged from 35° to 45°, averaging 40° for both years. Weak layer depth ranged from 0.05 to 0.54 m, averaging 0.26 m for 2003 - 2004 and 0.53 m for both years. Tester weight ranged from 65 to 93 Kg, averaging 78 Kg for 2003 - 2004 and 76 Kg for both years.

Normal sized AK Block results averaged 0.08 step lower than the corresponding Rutschblock results. Only nine percent of the Rutschblocks fractured at the cut in 2003 - 2004, and only 13 percent in both years.

The snowpack was too strong for ideal testing this year. Many blocks tested an obviously off-scale seven (no fracture) in snow so hard to dig that it was readily apparent that test values were not going to change with increased load. These sites had to be discarded from tester weight – block size analysis, reducing the sample size.

But there were a few good samples to plot for preliminary evaluation. These were separated by their initial value at normal size for analysis. Those with initial values of seven and six are plotted here.

The x axis is the percentage block size departure from normal size. The y axis is the AK Block test value. The sites included in the data set are listed at the right, with the symbols for their data. These are plots of raw data, as our sample size is still too small to merit much statistical analysis. Data for lower test values is not available due to the strong snowpack.

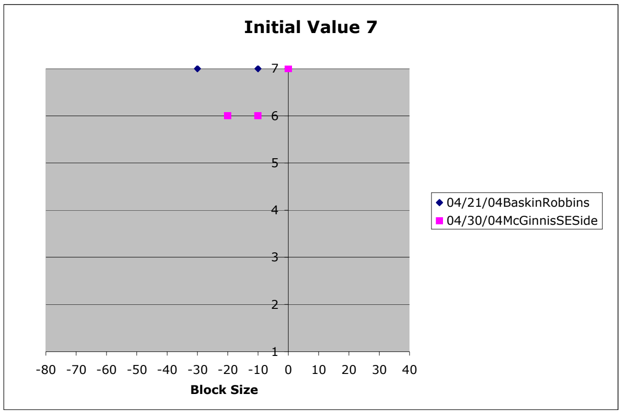

Figure 4. Results of tests with an initial AK Block value of seven (no fracture). Test value is plotted against block size, indicated as the percentage change from the normal size.

Figure 4 shows a decrease in test value with decreasing block size in the range beginning at seven, for a very limited sample of tests at the weaker end of that category. The stronger sevens are not plotted here because they showed no decrease. They were essentially off-scale.

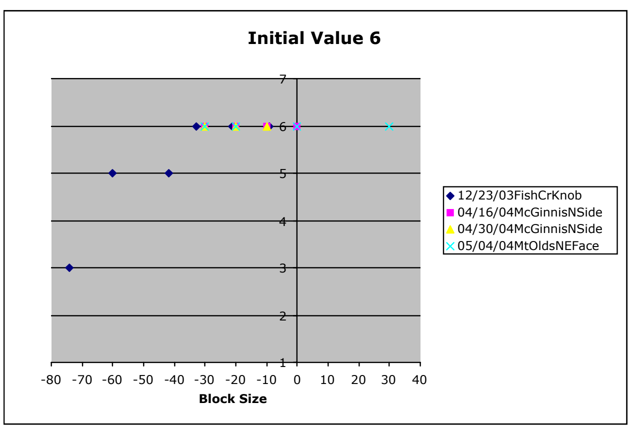

Figure 5. Results of tests with an initial AK Block value of six. Test value is plotted against block size, indicated as the percentage change from the normal size.

In Figure 5, block sizing in the range beginning at six shows a roughly linear relationship with test values. The plot is not smooth, but the sample size is small. A larger sample is needed to determine if it will smooth out or not.

In Figure 5, size changes as large as 20 to 30 percent do not show a change in test value. Again, the sample size is small, so the block size tolerance envelope cannot be defined yet.

No data is available yet for weaker snowpacks than an initial AK Block value of six. Further testing will be necessary to define the sensitivity of weaker snowpacks to block size.

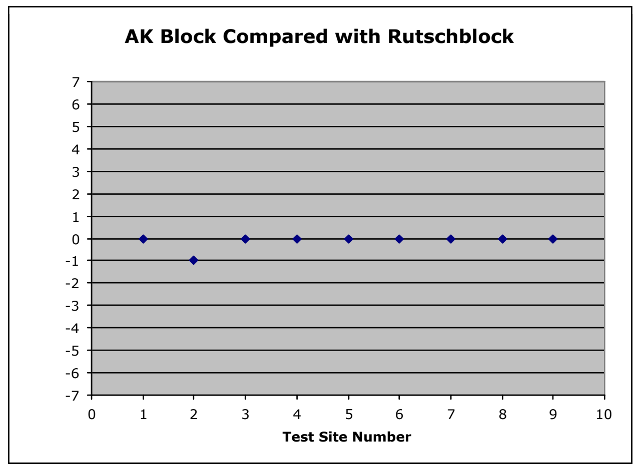

Figure 6. AK Block Compared with Rutschblock. The difference in test value between the normal sized AK Block and the Rutschblock is listed for each test site.

Figures 6 and 7 compare the normal sized AK Block values with the Rutschblock values for each site in the 2003-2004 study. Figure 6 shows the differences between the two tests at each site, and Figure 7 shows the values for each test at each site.

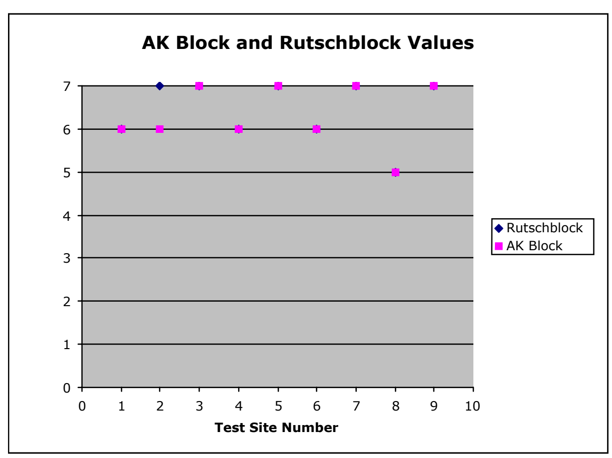

Figure 7. AK Block and Rutschblock test values for each site. There is only one site showing two values, because the AK Block and Rutschblock values were the same at all the other sites.

4. Summary and Conclusions

Our results are still preliminary. A larger sample spanning a full range of conditions, particularly weaker snowpacks, is needed to complete our analysis. The available study periods in the two winters did not offer the necessary snow conditions.

Our results suggest that cutting the back of test blocks is not significant when the block is sized to contact length. Normal sized AK Block and Rutschblock test results are virtually identical, and only 13 percent of our Rutschblocks fractured at the cut.

The block size – test value plots in Figure 5 suggest that our block sizing table produces values that change linearly with percentage changes in block size proportioned to the corresponding changes in tester weight.

These two principal hypotheses cannot be conclusively proven at this time, but the preliminary results of comparison of sized AK Blocks with Rutschblocks do support them:

- The AK Block gives reliable results without a cut back.
- Sizing the block to contact length and tester weight using our linear table based on percentages appears to work.

The AK Block appears to have these advantages:

- It is a simple test suitable for lay as well as professional use.
- It requires minimal equipment: a layout tool, a shovel, and skis or board to load it. Layout tools can be gear like probes, cords, skis, snowboards, or poles marked with measurements.
- There is no need for a saw to cut the back of the block, nor are there problems with inadequately cut backs.
- It has a large enough sample area to minimize the effects of small-scale spatial variability
- It allows comparison of results for testers of different weights
- Like any large block test, it gives direct gut-level decisionmaking feedback. The psychological references cited in the introduction suggest that gut-level feedback like feeling a block give way underfoot creates an emotional impact that more effectively influences decisionmaking than abstract feedback like that of the small block tests does.

5. Further Studies

5.1 Continue the current tests using a series of varying size blocks loaded by one tester to better define the tester weight – block size relationship.

5.2 Evaluate the sized blocks with several testers, ideally spread through the 50 to 100 Kg weight range, to see if they are consistent, using Rutschblocks and sized cutback blocks in each set for comparison and control. A likely secondary result of this stage of the project is development of a sized cutback block test.

5.3 Compare sized cut and non-cutback blocks, and blocks loaded with skis and snowboards.

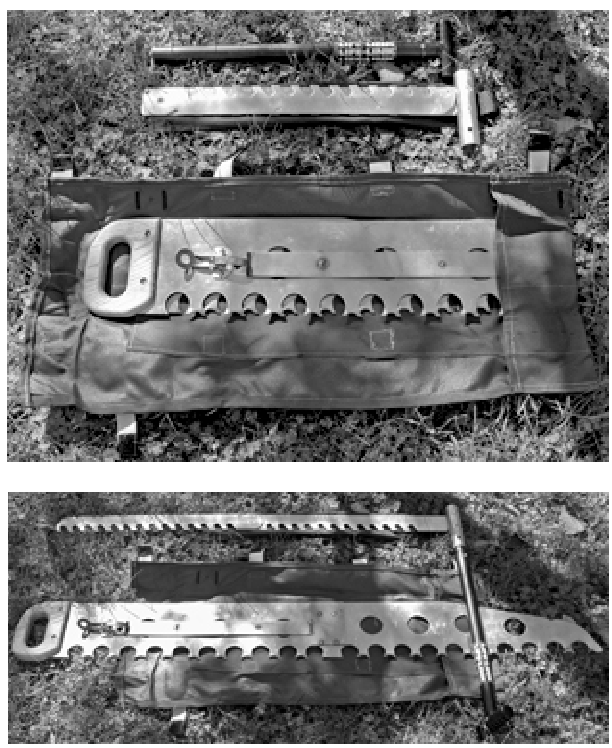

Figure 8. Contributors need good saws. We used Scott Flavelle's compact 1.00 m RB 100 snow saw with Life Link shovel handle for full-depth leverage,

and Canadian two-piece 1.30 m Rutschblock saw. Both are shown broken down and assembled.

5.4 Guidelines for workers who would like to contribute data:

- Check with the Southeast Alaska Avalanche Center at http://www.avalanche.org/~seaac/ for current guidelines and project status.
- Be ready, weak snow conditions are usually short-lived. Carry snow study gear and a good saw.
- There must be single weak layer. Comparison is between different weak layers does not work.
- Use a safe uniform slope big enough for four block pairs.
- Load blocks with skis only at this stage.
- Dig just past the weak layer to save time.
- Do one detailed profile to characterize the day's snowpack, including temperatures and densities. Note the weak layer type, weak layer location, and bottom of test block location on the snow profile.
- Do four Rutschblock-AK Block pairs sized in 20 Kg steps with one tester, alternating sides, working upslope. Start at normal size and go smaller if values are high. Go bigger if values are low.
- If the smaller block heights put testers too near the edge, shorten the block width.
- We need block size feedback. Should the block size table be shifted toward larger or smaller blocks? Does it work well for all tester weights and gear sizes?
- Record on a sketch map using Jack in the Box diagrams. Note slope angle, shear quality, tester weight, gear type, ski waist width, block type, width, height, and departure from normal size. Did the Rutschblock fracture at the cut?
- Take at least one digital photo of the site.

6. Acknowledgements

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Aug	wt lbs	264	253	242	231	220	209	198	187	176	165	154	143	132	121	110	99	88	77	66	55	44
2004	**Wt Kg**	**120**	**115**	**110**	**105**	**100**	**95**	**90**	**85**	**80**	**75**	**70**	**65**	**60**	**55**	**50**	**45**	**40**	**35**	**30**	**25**	**20**
	0.80	4.13	3.96	3.79	3.62	3.44	3.27	3.10	2.93	2.76	2.58	2.41	2.24	2.07	1.89	1.72	1.55	1.38	1.21	1.03	0.86	0.69
	0.85	3.89	3.73	3.57	3.40	3.24	3.08	2.92	2.76	2.59	2.43	2.27	2.11	1.95	1.78	1.62	1.46	1.30	1.13	0.97	0.81	0.65
	0.90	3.67	3.52	3.37	3.21	3.06	2.91	2.76	2.60	2.45	2.30	2.14	1.99	1.84	1.68	1.53	1.38	1.22	1.07	0.92	0.77	0.61
	0.95	3.48	3.34	3.19	3.05	2.90	2.76	2.61	2.47	2.32	2.18	2.03	1.89	1.74	1.60	1.45	1.31	1.16	1.02	0.87	0.73	0.58
	1.00	3.31	3.17	3.03	2.89	2.76	2.62	2.48	2.34	2.20	2.07	1.93	1.79	1.65	1.52	1.38	1.24	1.10	0.96	0.83	0.69	0.55
	1.05	3.15	3.02	2.89	2.76	2.62	2.49	2.36	2.23	2.10	1.97	1.84	1.71	1.57	1.44	1.31	1.18	1.05	0.92	0.79	0.66	0.52
	1.10	3.01	2.88	2.76	2.63	2.51	2.38	2.25	2.13	2.00	1.88	1.75	1.63	1.50	1.38	1.25	1.13	1.00	0.88	0.75	0.63	0.50
	1.15	2.88	2.76	2.64	2.52	2.40	2.28	2.16	2.04	1.92	1.80	1.68	1.56	1.44	1.32	1.20	1.08	0.96	0.84	0.72	0.60	0.48
	1.20	2.76	2.64	2.53	2.41	2.30	2.18	2.07	1.95	1.84	1.72	1.61	1.49	1.38	1.26	1.15	1.03	0.92	0.80	0.69	0.57	0.46
	1.25	2.65	2.54	2.42	2.31	2.20	2.09	1.98	1.87	1.76	1.65	1.54	1.43	1.32	1.21	1.10	0.99	0.88	0.77	0.66	0.55	0.44
	1.30	2.54	2.44	2.33	2.23	2.12	2.01	1.91	1.80	1.70	1.59	1.48	1.38	1.27	1.17	1.06	0.95	0.85	0.74	0.64	0.53	0.42
	1.35	2.45	2.35	2.25	2.14	2.04	1.94	1.84	1.73	1.63	1.53	1.43	1.33	1.22	1.12	1.02	0.92	0.82	0.71	0.61	0.51	0.41
	1.40	2.36	2.26	2.17	2.07	1.97	1.87	1.77	1.67	1.57	1.48	1.38	1.28	1.18	1.08	0.98	0.89	0.79	0.69	0.59	0.49	0.39
	1.45	2.28	2.19	2.09	2.00	1.90	1.81	1.71	1.62	1.52	1.43	1.33	1.24	1.14	1.05	0.95	0.86	0.76	0.67	0.57	0.48	0.38
	1.50	2.20	2.11	2.02	1.93	1.84	1.75	1.65	1.56	1.47	1.38	1.29	1.19	1.10	1.01	0.92	0.83	0.73	0.64	0.55	0.46	0.37
	1.55	2.13	2.04	1.96	1.87	1.78	1.69	1.60	1.51	1.42	1.33	1.24	1.16	1.07	0.98	0.89	0.80	0.71	0.62	0.53	0.44	0.36
	1.60	2.07	1.98	1.89	1.81	1.72	1.64	1.55	1.46	1.38	1.29	1.21	1.12	1.03	0.95	0.86	0.78	0.69	0.60	0.52	0.43	0.34
	1.65	2.00	1.92	1.84	1.75	1.67	1.59	1.50	1.42	1.34	1.25	1.17	1.09	1.00	0.92	0.84	0.75	0.67	0.58	0.50	0.42	0.33
	1.70	1.95	1.86	1.78	1.70	1.62	1.54	1.46	1.38	1.30	1.22	1.13	1.05	0.97	0.89	0.81	0.73	0.65	0.57	0.49	0.41	0.32
	1.75	1.89	1.81	1.73	1.65	1.57	1.50	1.42	1.34	1.26	1.18	1.10	1.02	0.94	0.87	0.79	0.71	0.63	0.55	0.47	0.39	0.31
	1.80	1.84	1.76	1.68	1.61	1.53	1.45	1.38	1.30	1.22	1.15	1.07	1.00	0.92	0.84	0.77	0.69	0.61	0.54	0.46	0.38	0.31
	1.85	1.79	1.71	1.64	1.56	1.49	1.42	1.34	1.27	1.19	1.12	1.04	0.97	0.89	0.82	0.74	0.67	0.60	0.52	0.45	0.37	0.30
	1.90	1.74	1.67	1.60	1.52	1.45	1.38	1.31	1.23	1.16	1.09	1.02	0.94	0.87	0.80	0.73	0.65	0.58	0.51	0.44	0.36	0.29
	1.95	1.70	1.63	1.55	1.48	1.41	1.34	1.27	1.20	1.13	1.06	0.99	0.92	0.85	0.78	0.71	0.64	0.57	0.49	0.42	0.35	0.28
	2.00	1.65	1.58	1.52	1.45	1.38	1.31	1.24	1.17	1.10	1.03	0.96	0.90	0.83	0.76	0.69	0.62	0.55	0.48	0.41	0.34	0.28
	2.05	1.61	1.55	1.48	1.41	1.34	1.28	1.21	1.14	1.08	1.01	0.94	0.87	0.81	0.74	0.67	0.60	0.54	0.47	0.40	0.34	0.27
	2.10	1.57	1.51	1.44	1.38	1.31	1.25	1.18	1.12	1.05	0.98	0.92	0.85	0.79	0.72	0.66	0.59	0.52	0.46	0.39	0.33	0.26
	2.15	1.54	1.47	1.41	1.35	1.28	1.22	1.15	1.09	1.03	0.96	0.90	0.83	0.77	0.70	0.64	0.58	0.51	0.45	0.38	0.32	0.26
	2.20	1.50	1.44	1.38	1.32	1.25	1.19	1.13	1.06	1.00	0.94	0.88	0.81	0.75	0.69	0.63	0.56	0.50	0.44	0.38	0.31	0.25
	AK Block height, choose from closest weight column (weight is without gear or clothing).																					

Table 1. Current AK Block sizing table. Sizes are in meters. This table should be considered a preliminary draft that will be refined as testing proceeds. Check the Southeast Alaska Avalanche Center website http://www.avalanche.org/~seaac/ for the most current version.