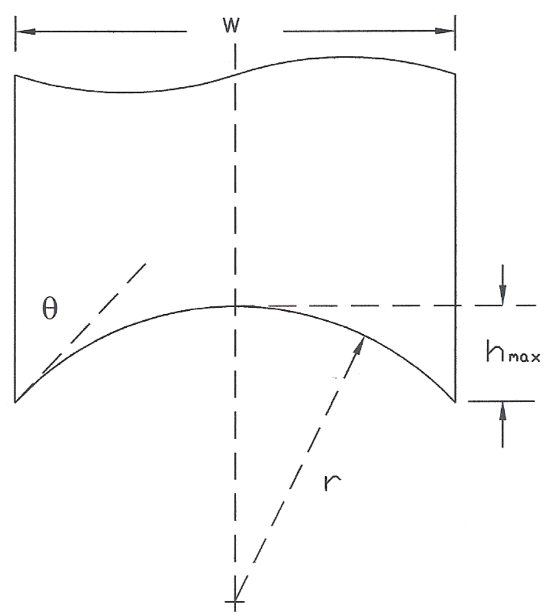
Black Stone Sports Inc.
Technical Information for Public Distribution

The Circular Arc

The circular arc profile is the traditional shape of the skate groove. This is because the traditional method of shaping the grinding wheel that is used to sharpen the skate blade is to swing a single point diamond tool in an arc about the centerline of the grinding wheel. Because of the widespread use of this profile, we will study its geometry in detail. The variables in the process are listed as follows:

- **w** – the width of the skate blade
- **r** – the radius of the circular arc
- θ – the included angle at the edge of the blade
- $\mathbf{h_{max}}$ – the maximum depth of the groove



This geometry is shown at right where the circular arc is shown as centered with the blade. The central location of the circular arc with respect to the blade is considered to be the best arrangement and is known as an edges even condition.

The interrelation between the variables can be determined from the following equations:

$$h_{max} = r\{1-\cos[\mathrm{asin}(w/2r)]\}$$

$$\theta = 90° - \mathrm{asin}(w/2r)$$

There are two variables that can be changed in the above equations; namely, the width of the skate blade, **w**, and the radius of the groove, **r**. The width of the blade, **w**, is dependent upon the type of skating being done, with the typical hockey blade being 0.110 inches (2.8 mm) wide. The typical radius, **r**, used by hockey players varies from 0.250 (6.35 mm) to 2.00 (50.8 mm) inches, with the most common radius being 0.50 (6.35 mm) inches.

Typical values of groove radius, **r**, when applied to hockey skates, 0.110 inches (2.8 mm) wide, will give the values of maximum depth, $\mathbf{h_{max}}$, and the edge angle, θ.

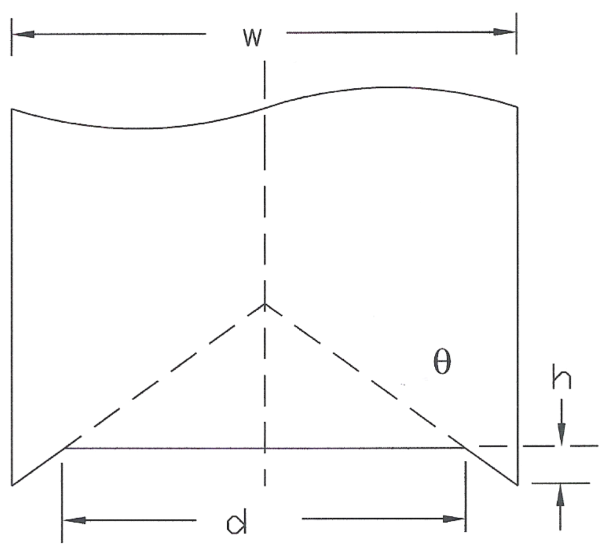
Radius, r (in)	Depth, h (in)	Edge Angle, θ
0.250	0.00613	77.29º
0.500	0.00303	83.68º
0.750	0.00202	85.79º
1.000	0.00151	86.85º
1.250	0.00121	87.48º
1.500	0.00101	87.90º
1.750	0.00086	88.12º
2.000	0.00076	88.42º

Two items are clearly demonstrated in the above chart, using the typical radii for sharpening ice skate blades provides depth, **h**, variations from 0.00613 to 0.00076 inches along with edge angles, θ, from 77.29º to 88.42º. Note that the range of edge angles, θ, and depths, **h**, is very limited. It is also common knowledge in the ice skating world that a smaller radius provides better turning ability along with a slower glide speed, while a larger radius provides superior glide speeds along with poorer turning ability.

The Flat Bottom 'V' (FBV)

This shape for the groove profile on an ice skate blade is an attempt to overcome the primary shortcoming of the traditional circular arc profile; the fact that the edge angle, θ, and the maximum depth of the groove, $\mathbf{h_{max}}$, are linked, i.e. you cannot change one without changing the other. This is a major constraint of the circular arc profile.

In the figure at right, a cross section through an ice skate blade, is shown with a symmetrical flat bottom 'v' profile. This profile is named the flat bottom 'v' (abbreviated to FBV) because the two lower internal profile lines would intersect in a v shape if they were projected upward, and the bottom of the ice skate blade forms a flat bottom for the v shape resulting from that projection. There are a few geometric properties that define the shape of the FBV ice skate blade profile; the blade width, **w**, the width of the flat bottom, **d**, and the depth of the flat bottom,



h. The height under the blade, **h**, is the distance between a line joining the two blade edges and the flat bottom. The edge angle (θ), at the blade edge, in the case of a symmetrical (central to the blade width) location of the blade bottom is given by the following formula:

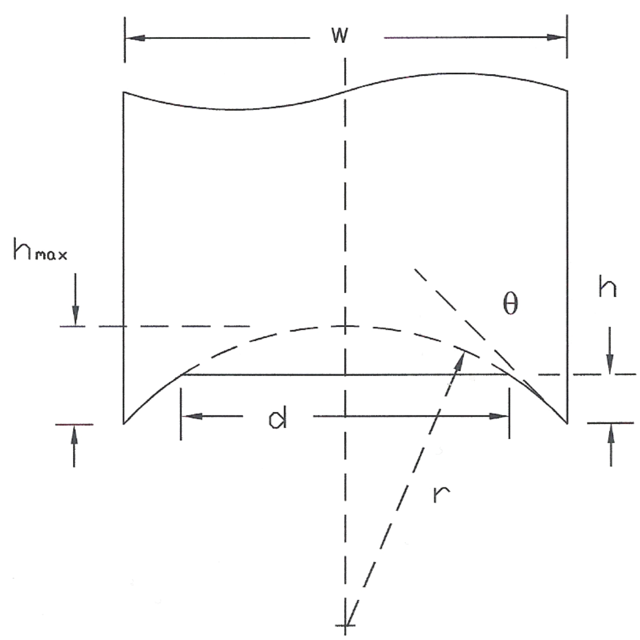
$$\theta = \text{atan}\{(w-d)/2h\}$$

As can be seen from this formula; once a blade width, **w**, is known, a value of blade bottom width, **d**, can be chosen in conjunction with the depth of the flat, **h**, to obtain a wide range of edge angle (θ) values.

A naming system for symmetrical flat bottom v profiles has been chosen that names them as follows – **FBV-XXX–YY**. Where "**XXX**" represents the flat bottom width, **d**, in thousandths of an inch, and "**YY**" represents the depth of the flat, **h**, in thousandths of an inch. For example, an FBV-90-0.75 has a flat bottom width, **d**, of 0.090 inches and a depth of flat, **h**, of 0.00075 inches.

The Flat Bottom Circular Arc (FBC)

In the figure at right, a cross section through an ice skate blade is shown where a flat bottom has been added to the traditional circular arc profile, leaving the two interior circular arc profiles. In this case, the edge angle (θ) will remain the same as the edge angles (θ) calculated for circular arc profiles of various radii, **r**,(see above); however, the depth of flat, **h**, will be adjustable to any value less than the maximum depth, $\mathbf{h_{max}}$, under the blade previously calculated for the circular arc. The depth of the flat, **h**, is the distance between a line joining the two blade edges, and the flat bottom of the skate blade.



The width of the flat bottom, **d**, is given by the following equation:

$$\mathbf{d = 2[r^2 - (r - h_{max} + h)^2]^{1/2}}$$

The advantage of this profile over the traditional circular arc profile is that the edge angle (θ), can be maintained while the depth, **h**, of the profile is reduced, from, $\mathbf{h_{max}}$, leading to a potentially faster skate with less drag.

A naming system for the flat bottom circular arc profiles is proposed as follows:
FBC-XXX-YY: where,

XXX is the radius, **r**, of the circular arc in thousandths of an inch
YY is the depth of the flat, **h**, in thousandths of an inch

For example **FBC-250-0.5** would have a radius, **r**, of 0.250 inches and depth of flat, **h**, of 0.0005 inches.

Circular Arc Blade Profiles (Traditional)

					DEPTH	Inches			
	Edge								
	Angle,°	0.006	0.005	0.004	0.003	0.002	0.001	0.00075	0.0005
	89 - 90								
	88 - 89						1 5/8 R	2 R	
	87 - 88						1 1/8 R		
	86 - 87					7/8 R	1 R		
	85 - 86					3/4 R			
	84 - 85					5/8 R			
	83 - 84				1/2 R				
	82 - 83								
	81 - 82			3/8 R					
	80 - 81								
	79 - 80								
	78 - 79								
	77 - 78	1/4 R							
	76 - 77								
	75 - 76								

FLAT BOTTOM V PROFILES

					DEPTH	Inches			
Circular	Edge	**x**	**x**	**x**	**x**	**x**	**x**	**x**	
Arc Range	Angle,°	0.006	0.005	0.004	0.003	0.002	0.001	0.00075	0.0005
	89 - 90								
x	88 - 89								
x	87 - 88								90 x .05
x	86 - 87								
x	85 - 86							90 x .75	
x	84 - 85								100 x .05
x	83 - 84								
x	82 - 83								
x	81 - 82							100 x .75	
x	80 - 81								
x	79 - 80								
x	78 - 79								
x	77 - 78								
	76 - 77								
	75 - 76								