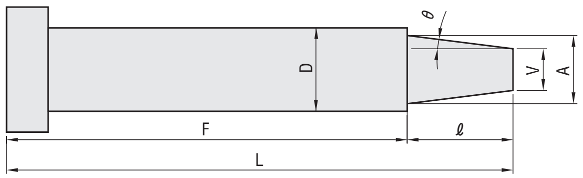
■Round Core Pins: Computing the Gradient θ of the Shaped Section



	Step 1A	Step 1B・1E	Step 1C	Step 1D
Gradient θ computation	$\theta=\tan^{-1}\frac{D-V}{2\ell}$	$\theta=\tan^{-1}\frac{A-V}{2\ell}$	$\theta=\tan^{-1}\frac{A-V}{2\ell-D+A}$	$\theta=\tan^{-1}\frac{A-V}{2(\ell-C)}$
V dimension computation	$V=D-2\ell\tan\theta$	$V=A-2\ell\tan\theta$	$V=A-(2\ell-D+A)\tan\theta$	$V=A-2(\ell-C)\tan\theta$

For the shaft diameter designation (0.01 mm increments) type, calculate using P for D.
Calculation of $\tan^{-1}$ (arc tangent) is simple using a function calculator.

● How to derive the $\tan^{-1}$ (arc tangent) value from the trigonometric function antilogarithm table

■To find $\tan^{-1}(x)$, please refer to the trigonometric function antilogarithm table.

When the x of $\tan^{-1}(x)$ is less than or equal to 1

①Locate the tan θ antilogarithm column from among the trigonometric functions listed in the top section of the antilogarithm table, then proceed down the column until you find the relevant value.
②The angle for θ in the left—hand column for that value will be equal, for the most part, to the calculated value for $\tan^{-1}$.

(ex.) $\tan^{-1}(0.0875)≒5°\ 00'$
$\tan^{-1}(0.0850)=4°\ 50'\ \sim 5°\ 00'$

When the x of $\tan^{-1}(x)$ is greater than or equal to 1

①Locate the tan θ antilogarithm column from among the trigonometric functions listed in the bottom section of the antilogarithm table, then proceed up the column until you find the relevant value.
②The angle for θ in the right-hand column for that value will be equal, for the most part, to the calculated value for $\tan^{-1}$.

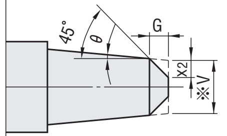
(ex.) $\tan^{-1}(1.4281)≒55°\ 00'$
$\tan^{-1}(1.4315)=55°\ 00'\ \sim 55°\ 10'$

θ	When deg =0° 00' ~11° 50'				
deg	sin θ	cos θ	tan θ	cot θ	
0° 00'	.0000	1.0000	.0000	∞	90° 00'
・	・	・	・	・	・
・	・	・	・	・	・
・	・	・	・	・	・
30	.0785	.9969	.0787	12.706	30
40	.0814	.9967	.0816	12.251	20
50	.0843	.9964	.0846	11.826	10
5° 00'	.0872	.9962	.0875	11.430	85° 00'
10	.0901	.9959	.0904	11.059	50
20	.0929	.9957	.0934	10.712	40
30	[illegible]	[illegible]	[illegible]	[illegible]	30

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40
30	.5664	.8241	.6873	1.4550	30
40	.5688	.8225	.6916	1.4460	20
50	.5712	.8208	.6959	1.4370	10
35° 00'	.5736	.8192	.7002	1.4281	55° 00'
10	.5760	.8175	.7046	1.4193	50
20	.5783	.8158	.7089	1.4106	40
30	.5807	.8141	.7133	1.4019	30
40	.5831	.8124	.7177	1.3934	20
50	.5854	.8107	.7221	1.3848	54° 10'
	cos θ	sin θ	cot θ	tan θ	deg
	When deg =54° 10' ~66° 00'				θ

Reference Data: Method for Computing Dimensions During Tip Shape Selection (※V is the dimension prior to tip shape processing.)

C (Chamfering)



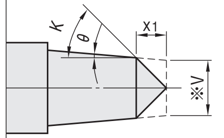
G=Standard: 0.1mm increments
Precision・Extra precision: 0.05mm increments
$0.5 \leqq G < \frac{V}{2}$
$\theta < 45°$

$x_2=G(1-\tan\theta)$

Processing limit value α for ℓ: α=G

θ=0° ⋯▸ G=x2
θ>0° ⋯▸ G>x2

G (Cone cutting)

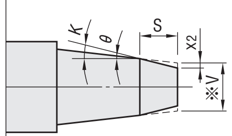


K=1° increments
20<K≦60 and θ=K

$x_1=\frac{V}{2(\tan K-\tan\theta)}$

Processing limit value α for ℓ:
$\alpha=\frac{V}{2\tan K}$

T (Tapering)

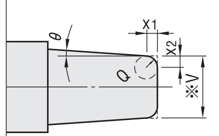


S=Standard: 0.1mm increments
Precision・Extra precision: 0.05mm increments
$0.1 \leqq S < \frac{V}{2\tan K}$
K=1° increments
10≦K≦45 and θ<K

$x_2=S(\tan K-\tan\theta)$

Processing limit value α for ℓ: α=S

R (Rounding)



Q=0.1 mm increments
0.2≦Q≦V/2

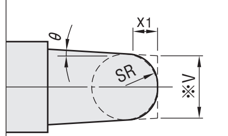
$x_1=Q(1-\sin\theta)$

$x_2=Q\{1-(1-\sin\theta)\tan\theta\}$

Processing limit value α for ℓ: α=Q

θ=0° ⋯▸ Q=x1=x2
θ>0° ⋯▸ Q>x1>x2

B (Spherical R)



SR=automatically determined.

SR±0.1
The spherical shape of the tip is not a perfect sphere.

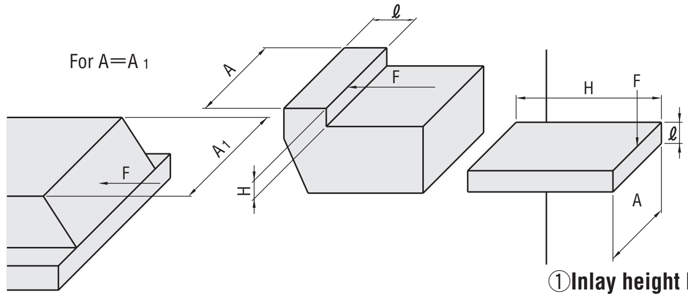
$$SR=\frac{\ell\cdot\tan\theta-\frac{A}{2}}{(1-\sin\theta)\cdot\tan\theta-\cos\theta}$$

$x_1=SR(1-\sin\theta)$

Processing limit value α for ℓ: $\alpha=\frac{V}{2}$

θ=0° ⋯▸ SR=x1
θ>0° ⋯▸ SR>x1

■Strength of Positioning Type Locking Block Inlay Sections



Considering the force acting on the inlay section to be cantilever

Bending Moment
$Mmax.=F\cdot H$

Section Modules
$Z=\frac{A\cdot\ell^2}{6}$

Allowable Stress
$$\sigma_b=\frac{Mmax.}{Z}=\frac{F\cdot H}{Z}$$
$$F=\frac{\sigma_b\cdot Z}{H}=\frac{\sigma_b\cdot A\cdot\ell^2}{6\times H}\ \text{\{maximum stress\}}$$

ex
A =25mm
ℓ =10mm
H =4mm, then

When the material is steel
σ_b=1200~1800kgf/cm² {11760~17640N/cm²}
Assuming that
σ_b=1200kgf/cm² {11760N/cm²}

$$F=\frac{1200\times2.5\times1^2}{6\times0.4}=\frac{3000}{2.4}=1250\text{kgf}\ \{12250\text{N}\}$$

Assuming stress concentrating factor α=2.5
{α=2.5when inlay corner area R is close to 0}

$$F=\frac{1250}{2.5}=500\text{kgf}\ \{4900\text{N}\}$$

①Inlay height H

The below table shows that the longer H is,
the lower maximum stress a locking block can endure.

H	F {maximum stress} kgf {N}	Strength coefficient
4	1250 {12258}	100
5	1000 {9800}	80
6	833 {8163}	67
7	714 {6997}	57
8	625 {6125}	50
9	556 {5449}	44
10	500 {4900}	40

②Inlay length ℓ

In the above case, maximum stress F_1, when ℓ is lengthened from 10 mm to 12 mm, is:

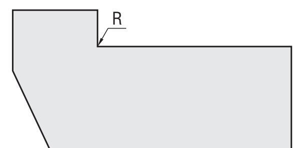
$$F_1=\frac{1200\times2.5\times1.2^2}{6\times0.4}=\frac{4320}{2.4}=1800\text{kgf}\ \{17640\text{N}\}$$

ℓ=10 ⋯▸ 12 $\quad \frac{F_1}{F}=\frac{1800}{1250}=1.44$

The calculation indicates that the strength of the inlay section is 1.44 times greater.

③Inlay corner area R

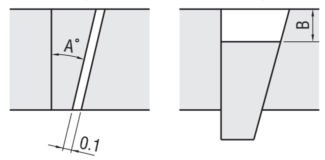
The larger R is, the smaller α (stress concentrating factor) becomes.
Therefore, the maximum stress exerted on the locking block increases.



Large R ⟷ Small R
1 ≦ α ≦ 3

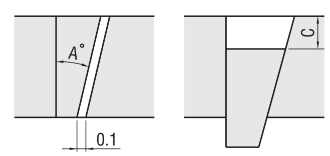
■Relationship Between Wedge Angle and Clearance

Sinking quantity of the wedge cut 0.1mm to inclined plane with an angle of A°



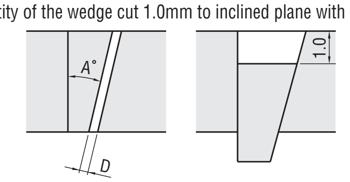
A	B	A	B	A	B	A	B
0° 30'	11.460	7°	0.820	16°	0.360	25°	0.240
1°	5.730	8°	0.720	17°	0.340	26°	0.230
1° 30'	3.820	9°	0.640	18°	0.320	27°	0.220
2°	2.870	10°	0.580	19°	0.310	28°	0.210
2° 30'	2.290	11°	0.520	20°	0.290	29°	0.210
3°	1.910	12°	0.480	21°	0.280	30°	0.200
4°	1.430	13°	0.440	22°	0.270	35°	0.170
5°	1.150	14°	0.410	23°	0.260	40°	0.160
6°	0.960	15°	0.390	24°	0.250	45°	0.140

Sinking quantity of the inclined plane when wedge sinking 0.1mm with an angle of A°



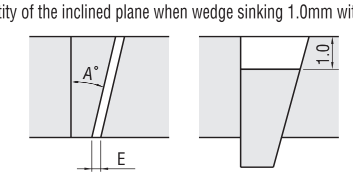
A	C	A	C	A	C	A	C
0° 30'	11.460	7°	0.810	16°	0.350	25°	0.210
1°	5.730	8°	0.710	17°	0.330	26°	0.200
1° 30'	3.820	9°	0.630	18°	0.310	27°	0.200
2°	2.860	10°	0.570	19°	0.290	28°	0.190
2° 30'	2.290	11°	0.510	20°	0.270	29°	0.180
3°	1.910	12°	0.470	21°	0.260	30°	0.170
4°	1.430	13°	0.430	22°	0.250	35°	0.140
5°	1.140	14°	0.400	23°	0.240	40°	0.120
6°	0.950	15°	0.370	24°	0.220	45°	0.100

Cutting quantity of the wedge cut 1.0mm to inclined plane with an angle of A°



A	D	A	D	A	D	A	D
0° 30'	0.009	7°	0.122	16°	0.276	25°	0.423
1°	0.017	8°	0.139	17°	0.292	26°	0.438
1° 30'	0.026	9°	0.156	18°	0.309	27°	0.454
2°	0.035	10°	0.174	19°	0.326	28°	0.469
2° 30'	0.044	11°	0.191	20°	0.341	29°	0.485
3°	0.052	12°	0.208	21°	0.358	30°	0.500
4°	0.080	13°	0.225	22°	0.375	35°	0.574
5°	0.087	14°	0.242	23°	0.391	40°	0.643
6°	0.105	15°	0.259	24°	0.407	45°	0.707

Cutting quantity of the inclined plane when wedge sinking 1.0mm with an angle of A°



A	E	A	E	A	E	A	E
0° 30'	0.009	7°	0.123	16°	0.287	25°	0.466
1°	0.017	8°	0.140	17°	0.306	26°	0.488
1° 30'	0.026	9°	0.158	18°	0.325	27°	0.510
2°	0.035	10°	0.176	19°	0.344	28°	0.532
2° 30'	0.044	11°	0.194	20°	0.364	29°	0.554
3°	0.052	12°	0.212	21°	0.384	30°	0.577
4°	0.070	13°	0.231	22°	0.404	35°	0.700
5°	0.087	14°	0.249	23°	0.424	40°	0.839
6°	0.105	15°	0.268	24°	0.445	45°	1.000