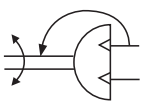
Series NR

Rotary Cylinder

Rack & Pinion-NRP

- LONG DURABILITY IS GUARANTEED BY THE INSTALLATION OF WEAR RING AND USE OF LOW FRICTION PACKING.
- SHOCK ABSORBER CAN BE INSTALLED(LOW NOISE).
- EASY TO ADJUST ANGLE BY STOPPER.
- COMPACT DESIGN.

Symbol



How to order

NRP | B | S | 50 | — | 90 | □ | W8H | S

1 | 2 | 3 | 4 | | 5 | 6 | 7 | 8

1 Rotary Cyl.
N : NEW
R : Rotary Cyl.
P : Rack Pinion

2 Mounting
B : Basic type
L : Foot type

3 Axis
Standard
S : Single axis
W : Double axes

4 Bore Size
50, 63, 80, 100

5 Rotation Angle

Standard	90°	90°
	180°	180°
Sub standard	100°	100°
	190°	190°

※ For non indicated angle please contact us.

6 Cushion
Blank : None
C : Air cushion

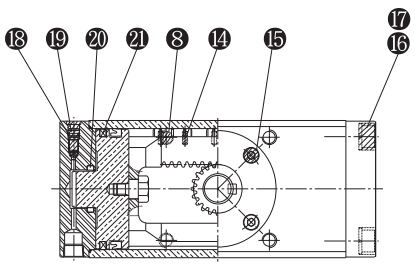
7 Auto Switch
Blank : None
W8H : Reed switch
W8V : Reed switch
W9H : Solid state switch
W9V : Solid state switch

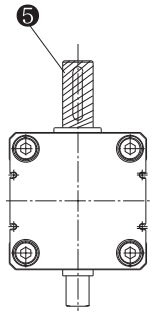
8 Number of Auto Switches
Blank : 2 pcs
S : 1 pc
N : N pcs

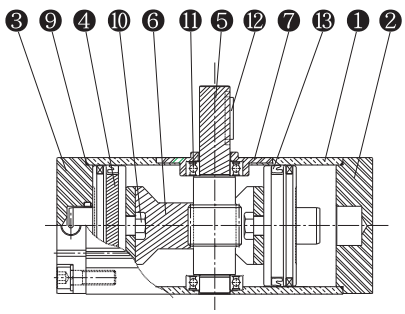
Specifications

Models		NRP 50	NRP 63	NRP 80	NRP 100
Bore Size(mm)		50	63	80	100
Rotation Angle (°)	standard	90^{+4}_{0} , 180^{+4}_{0}			
	substandard	100^{+4}_{0} , 190^{+4}_{0}			
Air Cushion	standard	×			
	option	○			
Theoretic Torque(kgf · cm) (based on 5 kgf/cm²)		98	187	377	785
Allowed Energy (kgf · cm)	without air cushion	0.475	1.14	1.52	5.225
	with air cushion	8.8	13.2	17.6	26.4
Port Size		Rc(PT)1/8	Rc(PT)1/8	Rc(PT)1/4	Rc(PT)3/8
Weight of Main Body(kgf)	90°	1.6	2.6	4.5	8.2
	180°	1.8	3.1	5.0	9.3
Maximum Radial Load (kgf)		20	30	40	60
Maximum Thrust Load (kgf)		50	60	90	100
Rotation Time(sec)	based on 90°	0.2 ~ 2	0.2 ~ 3	0.2 ~ 4	0.2 ~ 5
Fluid		Air(Non-lube)			
Pressure(kgf/cm²)		1.5~10.2			
Temperature · ℃(℉)		0 ~ 60℃(0~140℉)			
Action		Double operating			
Tolerance of rotation angle		0 ~ +4°			
Auto switch type		W8H,W8V			
		W9H, W9V			

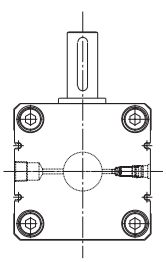
Construction/Parts List







Double shaft type

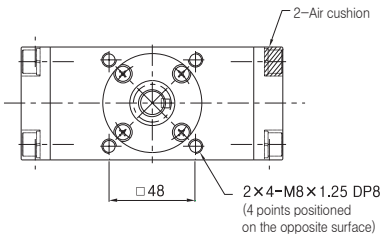


Parts List

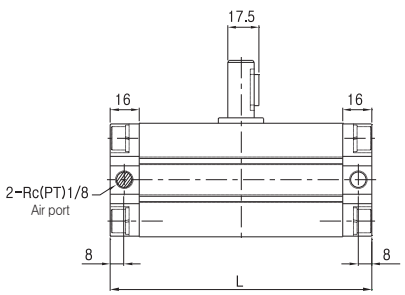
No.	Description	Material	Note
❶	Body	Aluminum alloy	
❷	Cover(right)	Aluminum alloy	
❸	Cover(left)	Aluminum alloy	
❹	Piston	Stainless steel	
	Piston(100˚, 190˚)	Stainless steel	Option
❺	Shaft	Aluminum alloy	
	Shaft(double)	Aluminum alloy	Option
❻	Rack	Carbon steel	
❼	Bearing retainer	Aluminum alloy	
❽	Slider	Resin	
❾	Tube gasket	Rubber	
❿	Connecring screw	Carbon steel	
⓫	Bearing	Bearing steel	
⓬	Parallel key	Carbon steel	
⓭	Piston packing	Rubber	
⓮	Spring pin	Steel wire	
⓯	Plush bolt	Carbon steel	
⓰	Bolt-hex socket	Steel wire	
⓱	Spring washer	Steel wire	
⓲	Cushion valve o-ring	Rubber	
⓳	Cushion valve	Rolled steel	
⓴	Cushion packing	Rubber	
㉑	Magnet	Magnet type	

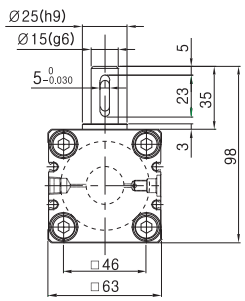
Ø 50

(mm)

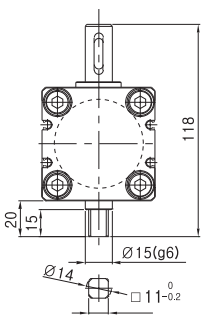


Rotation angle	90°	180°
L	157	190



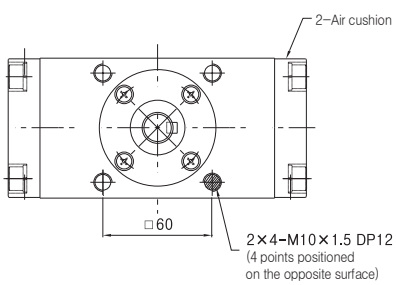


Double shaft type

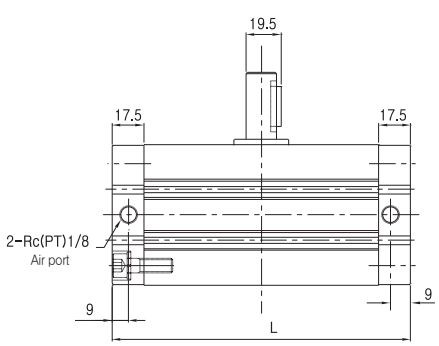


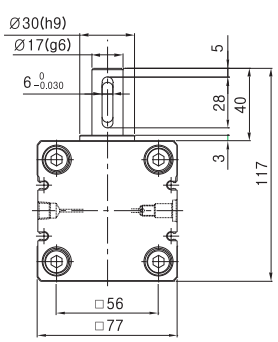
Ø 63

(mm)

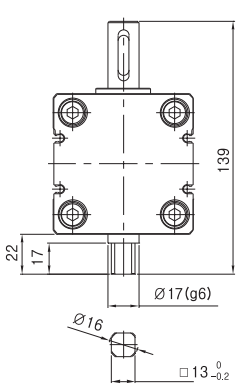


Rotation angle	90°	180°
L	176	224.5





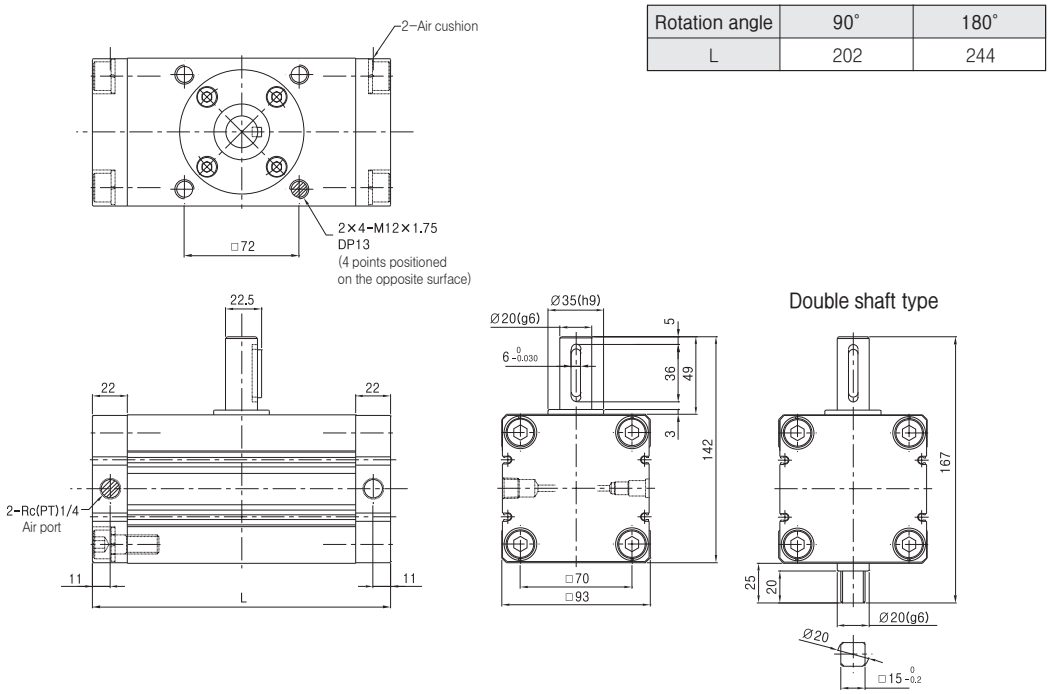
Double shaft type



Ø 80

a

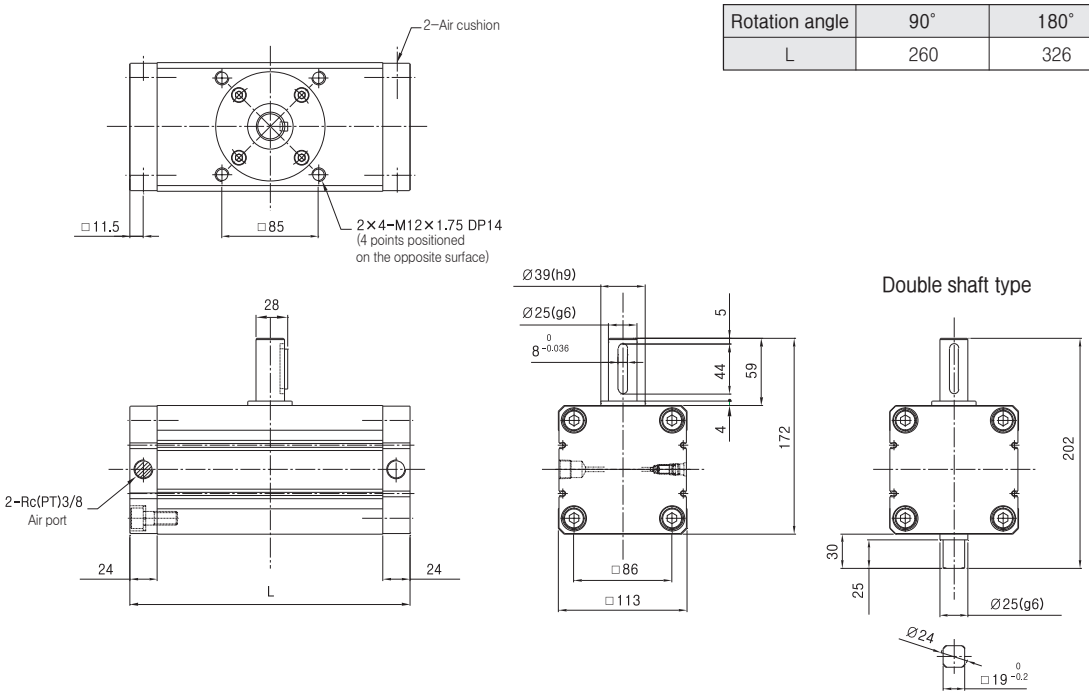
Rotation angle	90°	180°
L	202	244



Ø 100

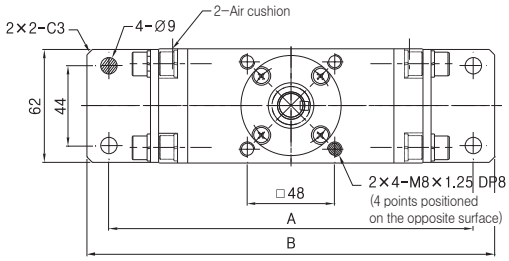
(mm)

Rotation angle	90°	180°
L	260	326

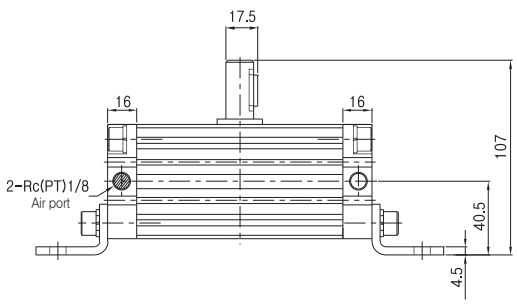


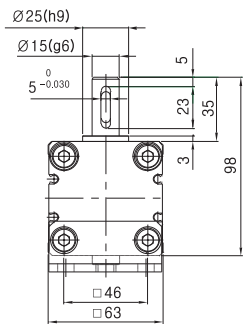
Ø 50

(mm)



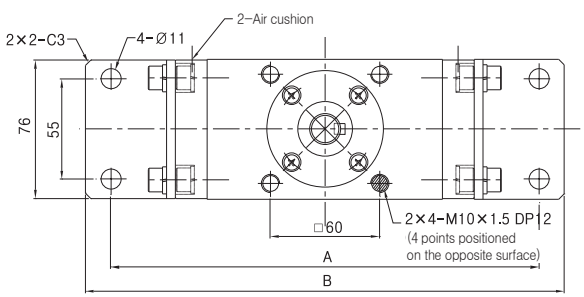
Rotation angle	90°	180°
A	212	245
B	236	269



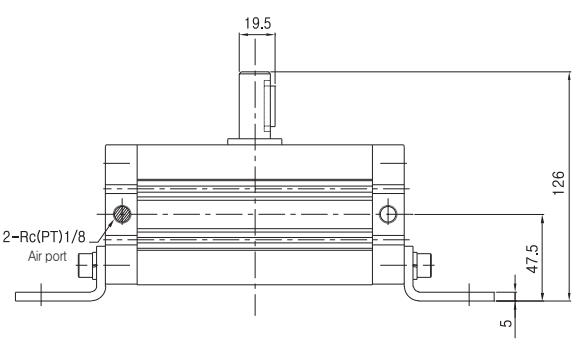


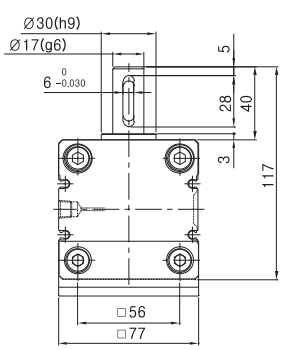
Ø 63

(mm)



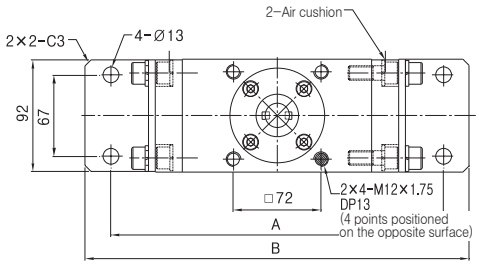
Rotation angle	90°	180°
A	247	295.5
B	275	323.5



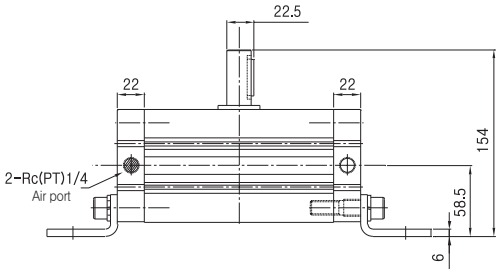


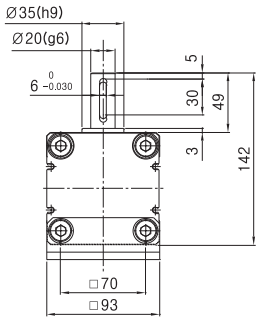
Ø 80

(mm)



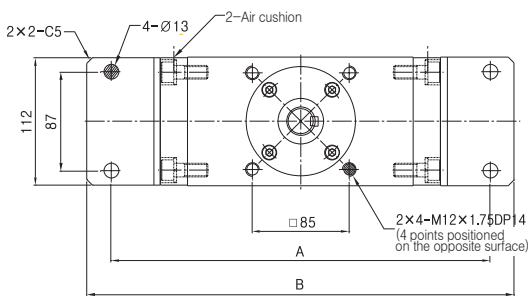
Rotation angle	90°	180°
A	274	318
B	316	360



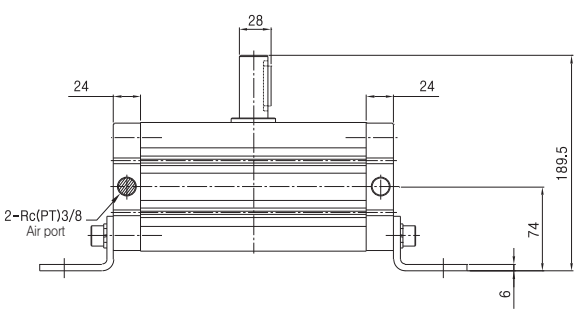


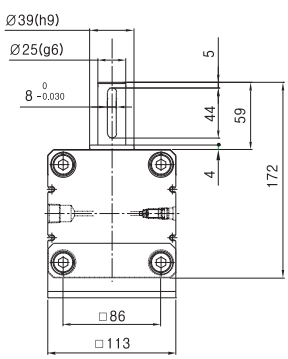
Ø 100

(mm)



Rotation angle	90°	180°
A	347	413
B	389	455

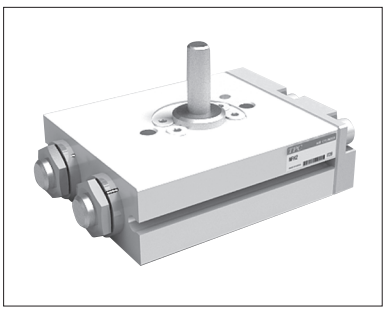




Series NR

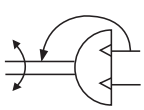
Rotary Cylinder

Rack & Pinion Compact type-NRC



- RACK AND PINION TYPE
- BACKLASH IS MINIMIZED TO DETERMINE THE POSITION, IN HIGH PRECISION BY USING DOUBLE RACK
- POSSIBLE TO CANTROL ANGLE AS WELL AS CUSHION STROKE
- AUTO SWITCH IS ATTACHABLE FOR DETECTING OPENING AND CLOSING

Symbol



How to order

NRC [1] W [2] 20 [3] — 90 [4] — W8H [5] ( ) [6]

[1] Rotary cyl.
N : New
R : Rotary cyl.
C : Compact

[2] Axis
Standard
S : Single axis
W : Double axes

[3] Size
12, 15, 20, 30

[4] Rotation Angle
90 : 90°
180 : 180°

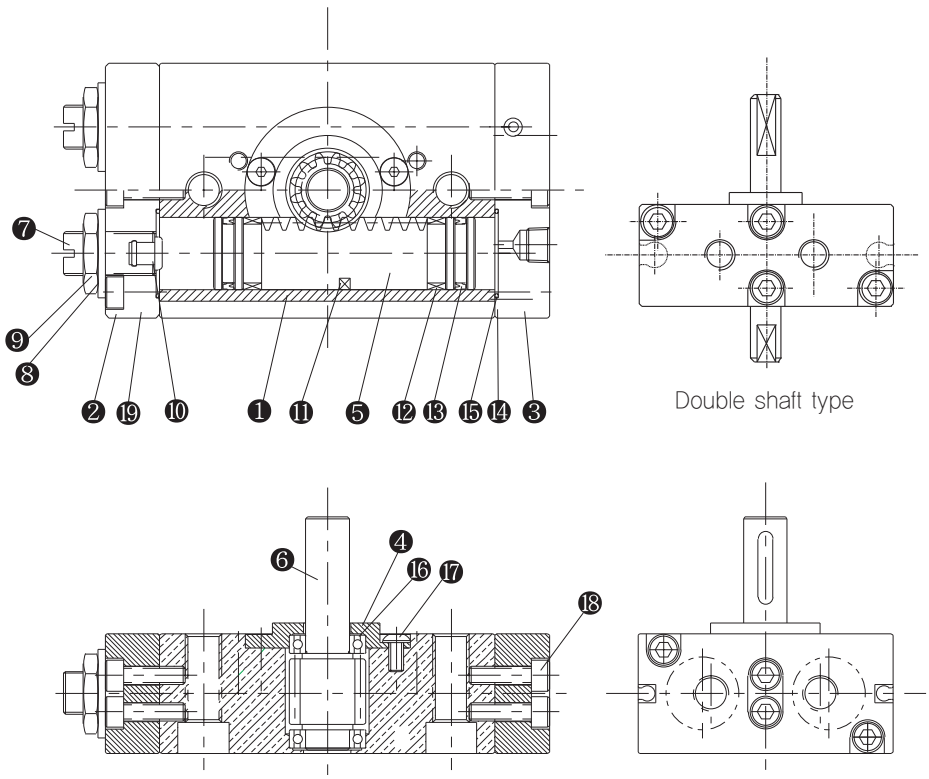
[5] Auto Switch
Blank : None
W8H : Reed switch
W8V : Reed switch
W9H : Solid state auto switch
W9V : Solid state auto switch

[6] Number of Auto Switches
Blank : 2 pcs
S : 1 pc
N : N pcs

Specifications

Models		NRC 12	NRC 15	NRC 20	NRC 30
Bore Size(mm)		10	13	18	20
Rotation Angle and Regulating Range(°)		90±5 180±5			
Cushion	adjusting bolt attached	Urethane			
	shock absorber attached	Shock absorber			
Theortic Torque (kgf · cm) (based on P=5 Kgf/cm²)		3.53	7.96	20.35	28.26
Allowed Energy (kgf · cm)	without cushion	0.07	0.12	0.24	0.46
	shock absorber attached	0.7	1.2	2.5	3.8
Air Supply port size		M5	M5	PT 1/8	PT 1/8
Maximum Radial Load (kgf)		1.5	2	5	8
Maximum thrust Load (kgf)		1.6	2	5	10
Rotation Time (sec) based on 90°	adjusting bolt attached	0.2 ~ 0.7	0.2 ~ 0.7	0.2 ~ 1	0.2 ~ 1
	shock absorber attached	0.2 ~ 0.5	0.2 ~ 0.5	0.2 ~ 0.7	0.2 ~ 0.7
Fluid		air			
Pressure		1.5 ~ 7.1kgf/cm²(21~101psi)			
Lubrication		unnecessary			
Temperature · ℃(℉)		0 ~ 60℃(0~140℉)			
Action		Double operating			
Auto switch type		W8H,W9H			
		W8V, W9V			

Construction/Parts List

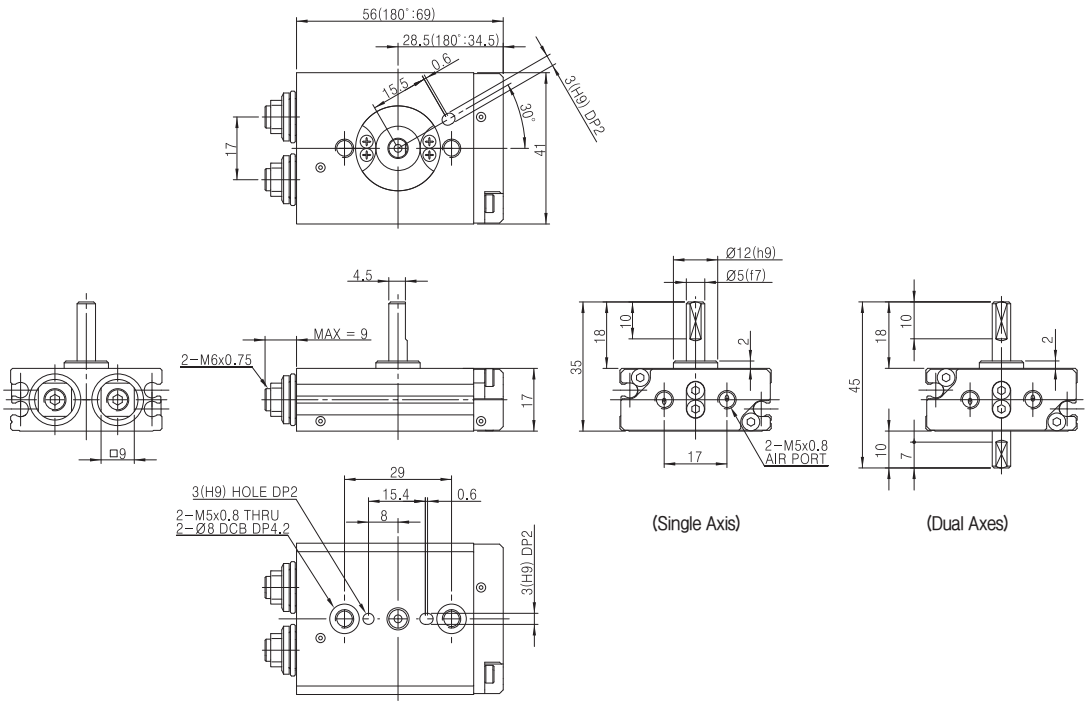


Parts List

No.	Description	Material	Note
❶	Body-rotary	Aluminum alloy	
❷	Cover-end	Aluminum alloy	
❸	Cover-port	Aluminum alloy	
❹	Cover-shaft	Aluminum alloy	
❺	Piston-rack	Stainless steel	
❻	Shaft-rotary	Carbon steel	
❼	Stopper-adjust	Stainless steel	
❽	Seal washer	NBR+carbon steel	
❾	Nut-seal	Carbon steel	
❿	Cushion	Urethane	
⓫	Magnet	Magnet type	
⓬	Wear ring	Resin	
⓭	Piston packing	NBR	
⓮	O-ring	NBR	
⓯	O-ring	NBR	
⓰	Bearing-ball	Bearing steel	
⓱	Hex socket bolt	Carbon steel	
⓲	Bolt-hex socket	Carbon steel	
⓳	Shock absorber	-	Option

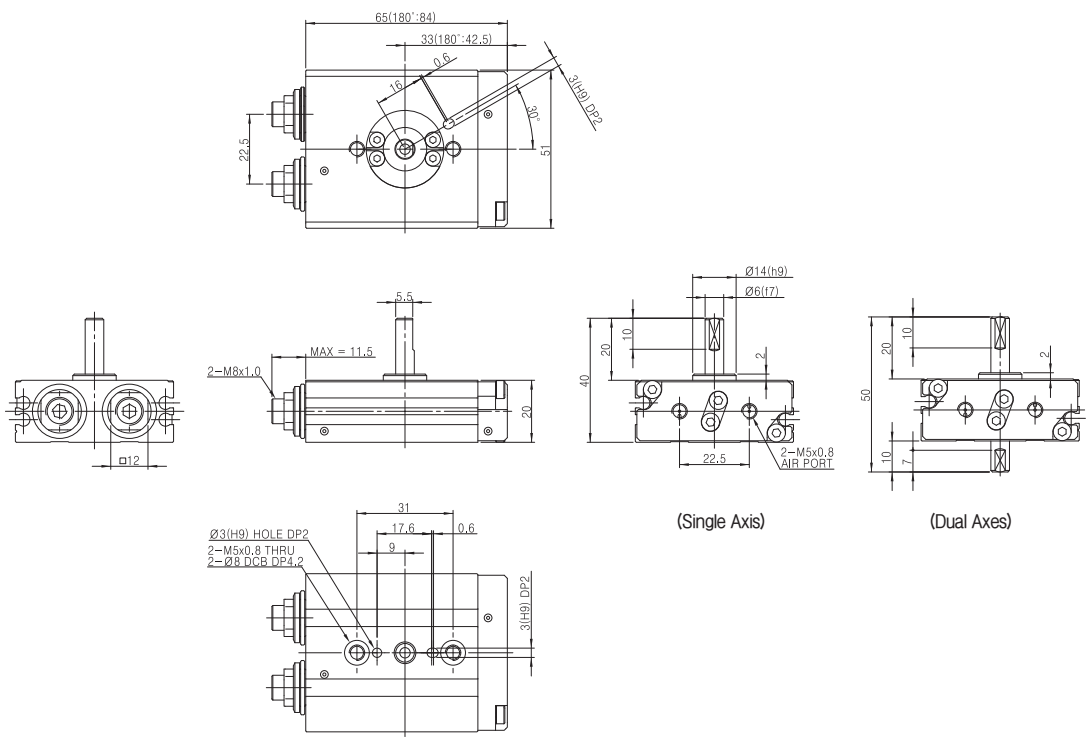
Ø 12

(mm)



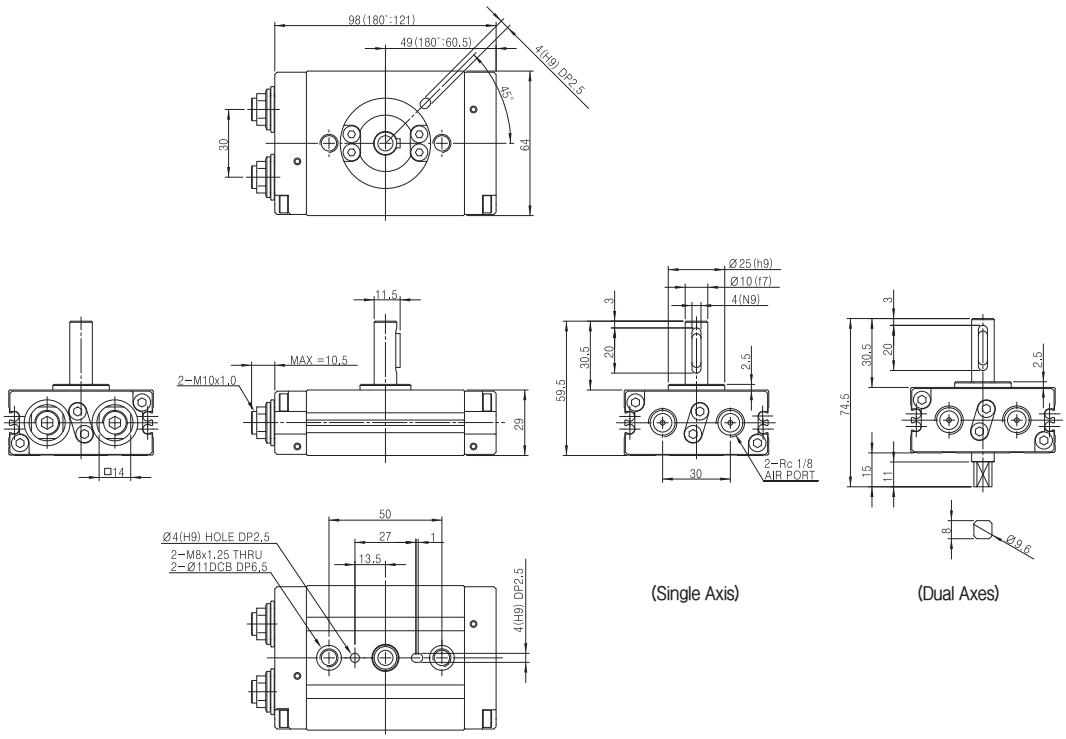
Ø 15

(mm)



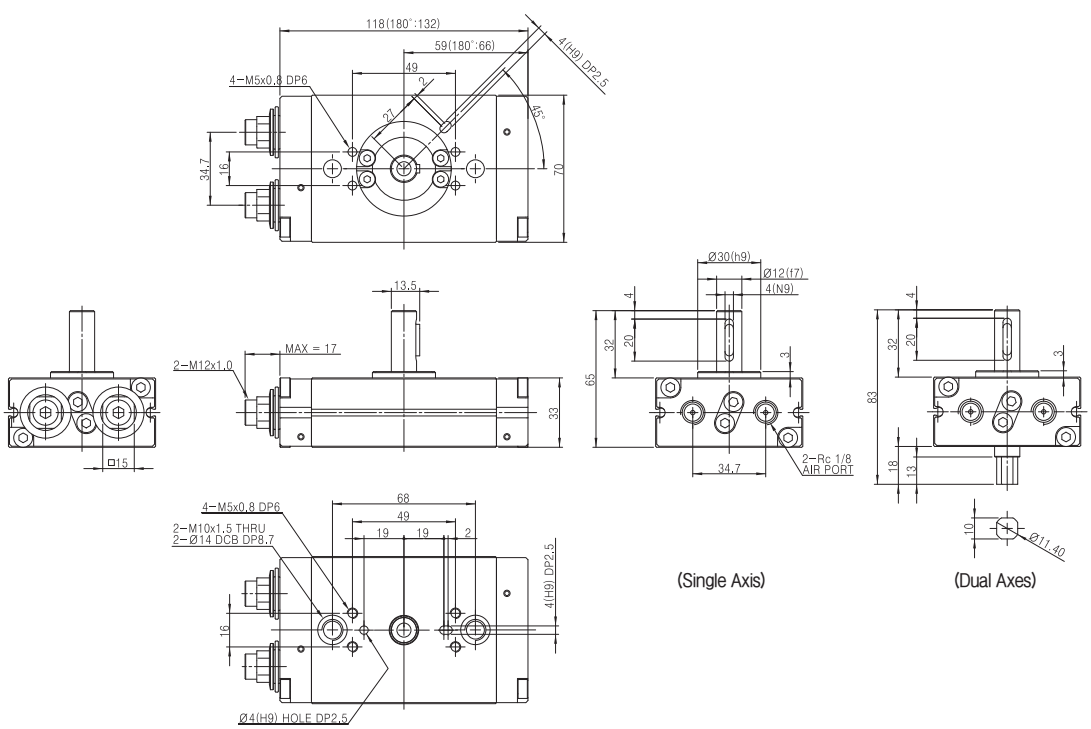
Ø 20

(mm)



Ø 30

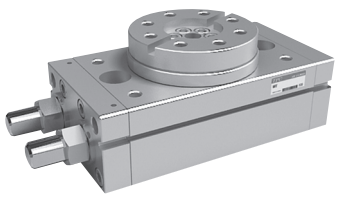
(mm)



Series NR

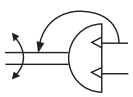
Rotary Cylinder

Rack & Pinion Table type-NRT



- REVOLVING ROTARY CYLINDER, DOUBLE PISTON TYPE(RACK AND PINION).
- SHOCK ABSORBER CAN BE INSTALLED.
- WIRING IS HANDLED IN SINGLE METHOD BY MIDDLE EMPTY AXIS.
- IT IS POSSIBLE TO REGULATE ANGLE AS WELL AS CUSHION STROKE.
- AN AUTO SWITCH CAN BE ATTACHED TO DETECT OPENING AND CLOSING.
- SMOOTH OPERATION AND HIGH POWER.
- HIGH PRECISION.
- A VARIETY OF MOUNTING OPTIONS.

Symbol



How to order

NRT (1) 30 (2) ○ (3) — W8H (4) S (5)

1 ROTARY CYL.
N : NEW
R : Rotary Cyl.
T : Table

2 Size
30, 50, 70, 100

3 Shock Absorber
Blank : Adjusting bolt
S : Shock Absorber

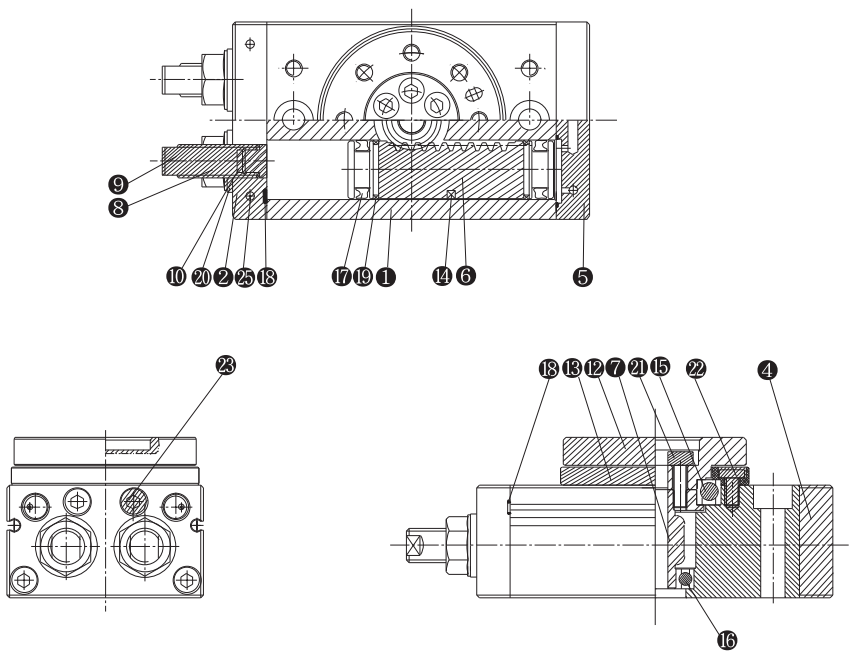
4 Auto Switch
Blank : None
W8H : Reed switch
W8V : Reed switch
W9H : Solid state switch
W9V : Solid state switch

5 Number of Auto Switches
Blank : 2 pcs
S : 1 pc
N : N pcs

Specifications

Models		NRT 30	NRT 50	NRT 70	NRT 100
Bore Size (mm)		2 × Ø22	2 × Ø25	2 × Ø28	2 × Ø32
Rotation Angle (°)		0 ~ 190°			
Cushion	adjusting bolt attached	Urethane			
	shock absorber attached	Shock absorber			
Theoretic Torque (kgf · cm)		31.3	51.5	75.4	102.5
Allowed Energy (kgf · cm)	without cushion	0.49	0.78	2.33	3.10
	shock absorber attached	1.041	2.639	9.68	14.08
Air Supply port size		PT1/8			
Weight (g)		1,310	2,030	3,110	4,300
Maximum Radial Load (kgf)		20	32	34	40
Maximum Thrust Load (kgf)		37	46	49	72
Rotation Time (sec) based on 90℃	adjusting bolt attached	0.2 ~ 1.0	0.2 ~ 1.0	0.2 ~ 1.5	0.2 ~ 2.0
	shock absorber attached	0.2 ~ 0.7	0.2 ~ 0.7	0.2 ~ 1.0	0.2 ~ 1.0
Fluid		Air			
Pressure		0.15~1.0MPa(21~145psi)			
Temperature · ℃(℉)		0 ~ 60℃(0~140℉)			
Action		Double operating			
Precision (mm)	Initial Value	±0.05			
	After operation in 1 million times	±0.07			
Auto switch type		W8H,W9V			
		W8H, W9V			

Structure/Parts List

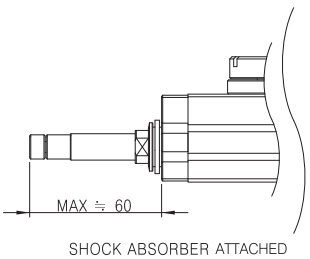


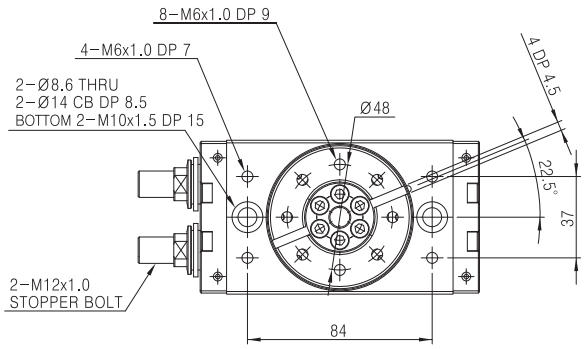
Parts list

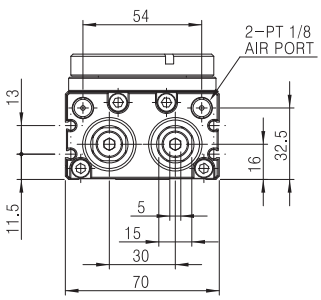
No.	Description	Material	Note
❶	Body	Aluminum alloy	
❷	Port cover	Aluminum alloy	
❹	Gasket	NBR	
❺	End cover	Aluminum alloy	
❻	Piston	Stainless steel	
❼	Pinion	Carbon steel	
❽	Flange nut	Carbon steel	
❾	Adjust bolt	Carbon steel	
❿	Cushion pad	Urethane	
⓬	Table	Aluminum alloy	
⓭	Bearing retainer	Aluminum alloy	
⓮	Magnet	Magnet type	
⓯	Ball bearing	Bearing steel	
⓰	Ball bearing	Bearing steel	
⓱	Piston packing	NBR	
⓲	Port o-ring	NBR	
⓳	Wearing	Resin	
⓴	Seal washer	NBRr+carbon steel	
㉑	Hex socket bolt	Carbon steel	
㉒	Hex socket bolt	Carbon steel	
㉓	Hex socket bolt	Carbon steel	
㉕	Steel ball	Carbon steel	
㉖	Shock absorber	Stainless steel	Option

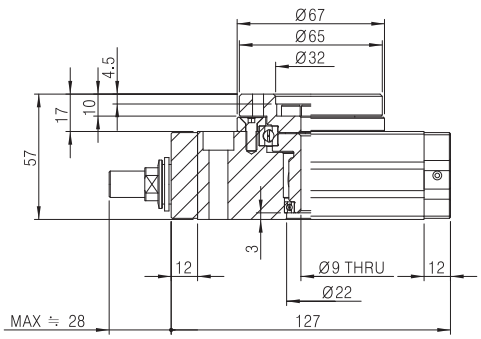
Ø 30

(mm)



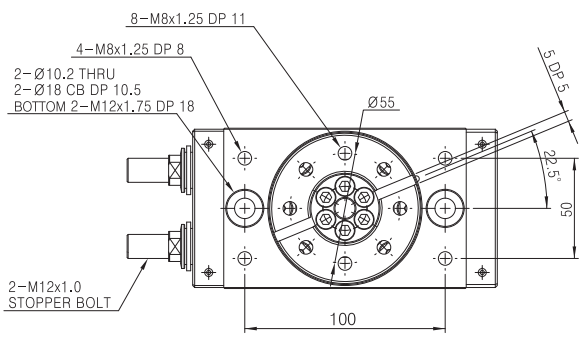


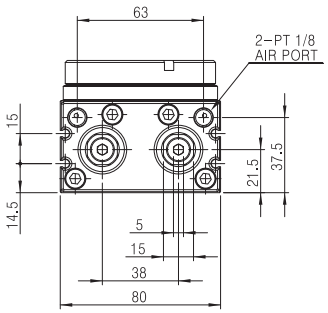


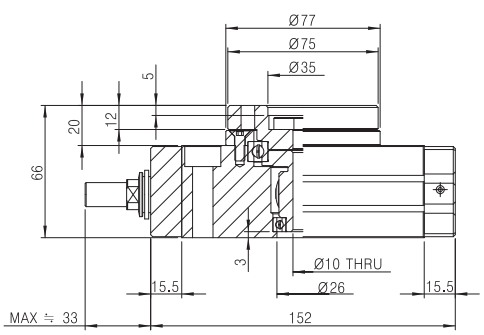


Ø 50

(mm)

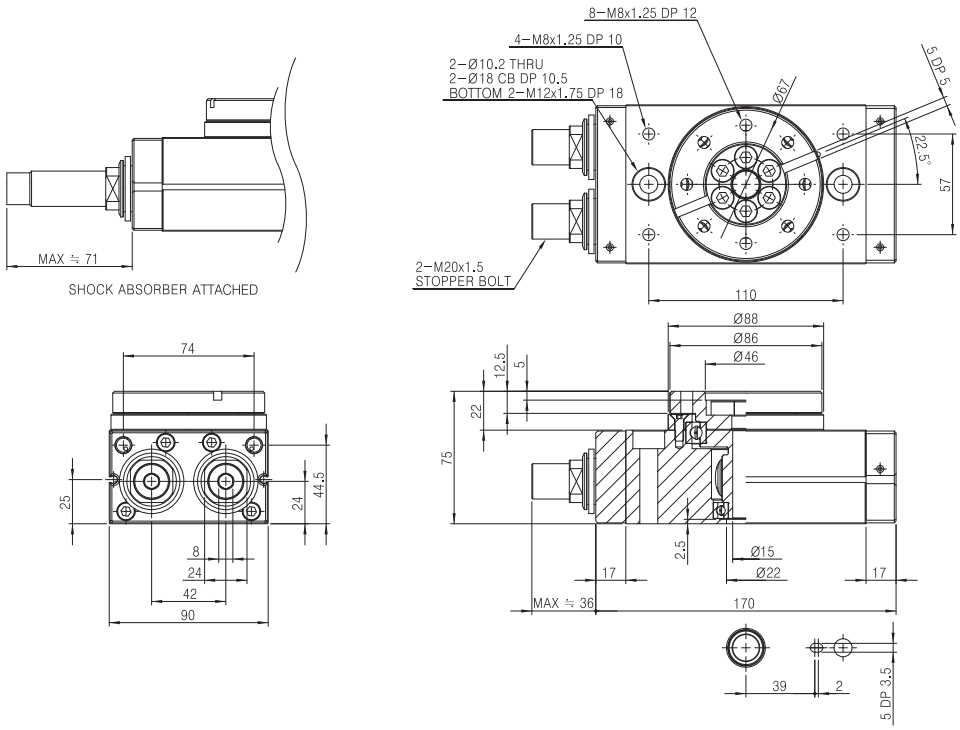






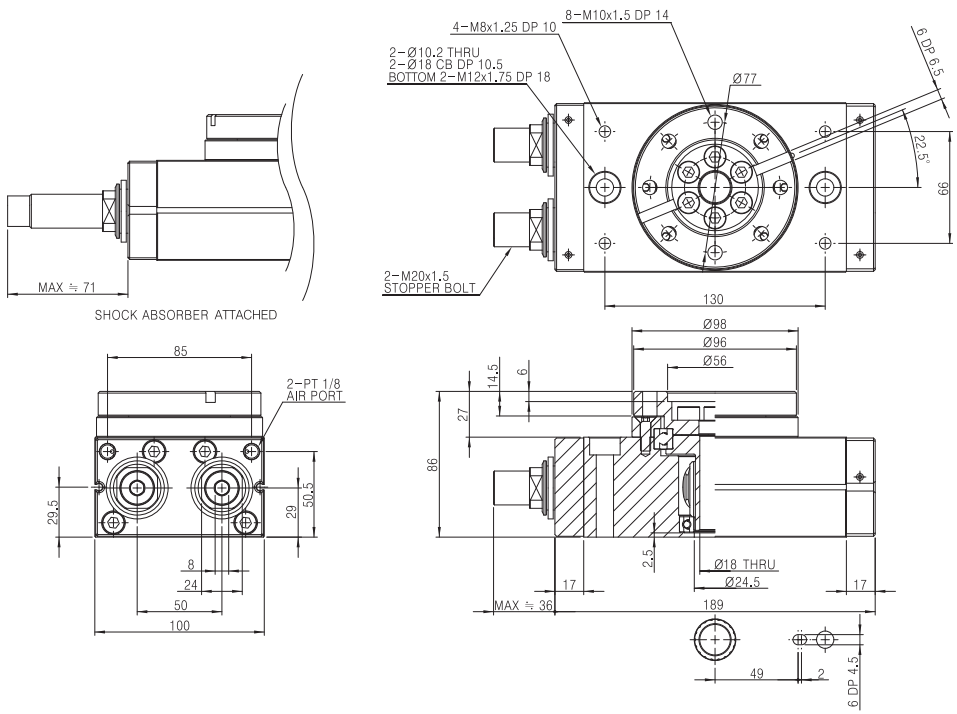
Ø 70

(mm)



Ø 100

(mm)



Common cautions for rotary cylinder series

Please make sure to read this prior to selecting and using our products and for detailed cautions of each series, see the details of the respective model.

Cautions for design

Warning

(1) It is needed to fasten firmly so as to prevent the fixing part or joint of rotary cylinder from being loose. Especially, it is preferred that rotary cylinder should be fastened by the surest way in place

(2) By attaching protective cover, it is possible to prevent any possible injury to the operation.

(3) It may be necessary to provide decelerating circuit or shock absorber.

(4) Rotary cylinder may be subject to the risk of malfunction if power changes due to distortion of sliding part of machine

(5) At the time when you design circuit, it is recommended to consider a prepare restart procedure for after an emergency stop.

Cautions for design

Danger

The use of product for the following purpose should be avoided.

1. For the use of medical use equipment designed to treat human body.
2. For the use of mechanical device or equipment designed to transport or move persons.
3. For the use of mechanical device that needs the maximum stability.

Warning

(1) Confirm the specification.

Be sure that the products in this catalog are designed to be used for industrial compressed air system only. When it is used for allowed energy of load, pressure or temperature beyond the range of specification, it may cause damage or malfunction.

(2) Vibration and shock.

The use of rotary cylinder should be avoided to absorb the vibration and shock of mechanical device.

(3) Concerning intermediary stop.

If at the middle of a direction control valve (3-position closed center type), the rotary cylinder piston stops,it cannot be precisely stopped at exact position like oil pressure because of compressed air. Furthermore, since it is impossible to guarantee prevention of air leakage using valve and rotary cylinder, the stopping position may not be maintained for long time, resulting in damage to human body or equipment.

(4) In event that the kinetic energy on the product exceeds tolerance, be sure to install buffer.

Over energy may break product, resulting in damage to human body, instrument or equipment.

Caution

(1) Confirm all specification.

Otherwise, durability may decrease and abnormal wearing or damaging of shaft/internal parts may occur.

(2) Over load external torque exceeding the specified power to the product should be avoided.

(3) Be sure to always increase the speed gradually by attaching speed controller when the rotary cylinder is running.

(4) The use of the product in the low speed area beyond the speed controlling range indicated in the product should be avoided.

Stick slip or stopping of operation may occur due to using low speeds.

(5) Sufficient tolerance is needed in torque

Be sure to select a model so that the required torque is less than 70% of theoretic torque (less than 50% in the case of variable load). If mass of load is large, andoperating speed is fast, the inertia load gets too large exceeding the allowed energy of rotary cylinder, so that the product may be broken resulting in fatal injury to the operation or damage to instruments or equipment. In this case, it is preferred to install shock absorber so as to prevent the inertia power from being directly applied to rotary cylinder.

(6) The use of the product using oil pressure (except NRP for low oil pressure) should be avoided.

The product can be seriously damaged if it is used with the oil pressure.

Cautions for selection

Danger

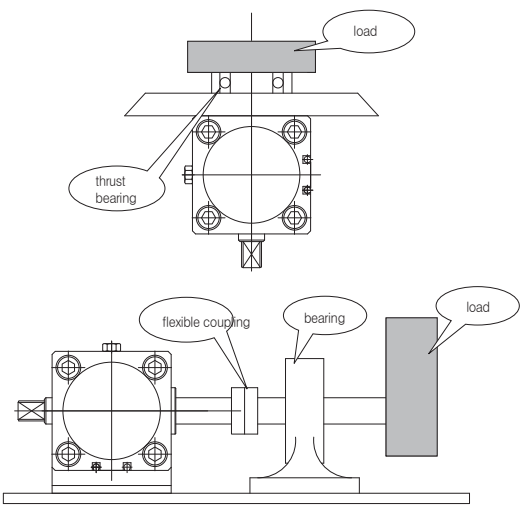
(1) Be sure to always check whether it is fixed in safety when attaching the product.

Dropping the product or irregular operation may result in injury.

(2) Water must be kept away from the product.
Sprinkling water to the product, washing it with water or using it in the water should be avoided, otherwise it may cause malfunction, resulting in injury, electric shock, fire, etc.
(3) Touching it should be avoided while the product is running.

Warning

(1) Space for maintenance and repair should be provided.
(2) Careful handling is needed with respect to cords such as lead wire of auto switch so as to prevent any possible damage.
(3) Putting auto switch in the external magnetic field is avoided while rotary cylinder is running.
(4) Installation of safety valve
So as to prevent the pressure from exceeding regular pressure, be sure to install safety valve when it is increasing because of external power applied to rotary cylinder. Over pressure may break the product.
(5) Modifying the product should be avoided.
(6) Fastening screw and observance of fastening torque are needed.
Fasten screw to the recommended torque while installing.
(7) Be sure to check that the revolving direction of rotary cylinder coincides with that of the load.
If the center of revolution does not coincide or moment weight is applied to the point of shaft, it is needed to put flexible coupling so that only the revolving power may be transmitted.
So as to achieve a running condition, be sure to let the load apply directly to shaft as described in the following diagram.



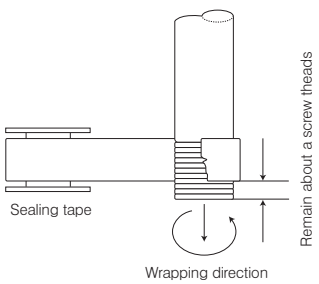
Cautions

(1) Applying load exceeding twisting or bending strength to the rotary cylinder shaft should be avoided.

Cautions for piping

Cautions

(1) Action prior to piping.
Make sure to clean piping in order to eliminate the chip, oil or dust in a pipe.
(2) Method of using seal pipe
In event that connecting piping or fitting is performed, it is needed to make sure to prevent the chip or sealing material of piping screw from entering into the inside of piping. Especially, wind it, leaving 1.5–2 threads of pipe untapped when using seal tape.



Cautions for adjusting the cushion

Cautions

(1) It is needed to adjust cushion valve again.
At the time of delivery, though cushion is adjusted, readjusting cushion valve installed on the cover based on the load and running speed used is needed. In the event that cushion valve is turned clockwise, the orifice hole becomes smaller and cushion becomes stronger. After adjusting, it is needed to fasten lock nut (if any) firmly.
(2) Using cushion valve should be avoided while it is completed closed.

Cautions for lubrication

Cautions

(1) No use of Lubrication
Be sure to use this product without lubrication. If needed, it may be used with lubrication; in this case stick slip will result.
So as to operate all in air hydro type, it is needed to lubricate turbine oil first class(without addition) ISO VG 32.
When other operating oil beyond designated model is used, failure results.
Using machine oil and spindle oil are avoided.

Cautions for air source

Cautions

(1) It is needed to attach air filter

The use of the product should be avoided in the place in which there are provided dust, salt, iron, powder, humidity, organic solvent, operating oil of phosphoric acid ester type sulfurous acid gas, chlorine gas, and the acids are contained. With the above conditions, operation delay, sudden deterioration of performance and reduction of durability may occur.

(2) The use of the product should be avoided in the place subjected to erosion.

For the equality of materials of rotary cylinder, it is needed to check each structure diagram.

(3) The use of the auto switch should be avoided in the strong magnetic field.

The use of the auto switch should be avoided in the place where there are provided high current or strong magnetism. Otherwise, it may cause malfunction. In particular, the use of the object which may be magnetized to the arranged bracket should be avoided.

Danger

(1) Hazardous substances such as flammables must be avoided.

Warning

(1) Do not use the product in the place where dust, salt, iron powder, humidity, organic solvent, operating oil of phosphoric acid ester type sulfurous acid gas, chlorine gas and the acids are contained. This condition may cause suspension of operation, sudden deterioration of performance and reduction of durability.

(2) Do not use the product in the place which is subject to erosion.

For the quality of materials of rotary cylinder, refer to each structure diagram.

(3) Auto switch must not be used in the strong magnetic field.

Do not use auto switch in the place with high current or strong magnetism, otherwise malfunction may occur. Especially, don't use object that can be magnetized to the installed bracket.

Cautions

(1) The use of the auto switch should be avoided together with this product.

Otherwise, malfunction or undesired operation could result.

It is needed to attach air filter to an upper stream provided near valve. It is preferred to set the filtering rate below 5um.

(2) It is needed to install following cooler, air dryer, drain catch etc. for preparation

Malfunction of valve or other air pressure equipment may be damaged due to compressed air with much drain.

(3) It is preferred to set the temperature of fluid and environment within the range of specification.

The circuit moisture could be frozen below 5C, resulting in damage and malfunction in packing. So, it is needed to prepare freezing phenomenon.

Cautions for environment for use

Danger

(1) The use of the product should be avoided in the place in which there are provided dust, salt, iron, powder, humidity, organic solvent, operating oil of phosphoric acid ester type sulfurous acid gas, chlorine gas, and the acids are contained. With the above conditions, operation delay, sudden deterioration of performance and reduction of durability may occur.

(2) The over force should be applied to the auto switch or rotary cylinder.

Cautions for repair

Danger

Person who uses pace maker should be kept away from the product within 1m.

Warning

The repair should be performed in the sequence of the manual. Otherwise, instrument or device may have malfunction or may be damaged.

Cautions

Inspection available on demand.

Even with high durability, air pressure apparatus could have deterioration of function. So as to prevent accident, it is needed to check that the needed function of system is normal with daily check.

How to select models

Caution: Load must not exceed the allowed limit. .

In the case of using rotary cylinder, most factors are studied in the context of inertia load. Erroneous selection for shape and weight of this inertia load, the internal parts may be broken by inertia power of load though the load required torque of rotary cylinder is not so large. For this reason, it is necessary to select right model.

1. Use Condition

Enumerate the use conditions in consideration of attaching direction and work shape.

- revolving angle : θ (rad) table 1
- rotation time : t (sec) table 1
- applied pressure : P (MPa)
- shape and weight of inertia load figure 1
- attaching direction: horizontal or vertical

1MPa ≒ 10.2kgf/cm²

2. Calculating the required rotation time

For selecting models, it is desirable to keep the speed in a controllable range.

Given the use conditions, the rotation time of rotary cylinder is obtained by the following expression. table 1

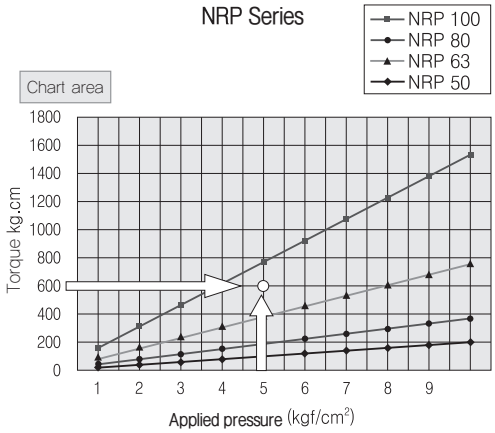
$$t \geq \sqrt{(2 \times I \times \theta^2 / E)}$$

E : allowed kinetic energy (J)
I : inertia moment (kgf · m²)
θ : revolving angle (rad)
90° → 1.57 rad
180° → 3.14 rad
t : rotation time (s)

3. Selecting the quantity of torque (selecting model)

For selecting models, torque necessary for revolution must be obtained to meet the object.

NRP Series



Referring to the above graph of theoretic torque, if torque of 600kgf.cm is necessary with applied pressure of 5kgf/㎠, the supplying pressure is extended to horizontal axis and torque, to vertical axis respectively to get the intersection. Inner diameter (NRP 100) larger than this intersection is to be selected.

Item	Horizontal Rotation	Vertical Rotation	Remark
static torque calculation(T_S)	–	$T_S = 2m \times L$	m : weight(Kgf) L : distance between revolving axis and load center(m)
accelerating torque calculation(T_A)	$T_A = I \times \omega_A \times K$		I : inertia moment(Kgf · m²) ω_A : each acceleration calculation(rad/s²) ω_A : ($2\theta/t^2$) K : safety coefficient, over 5
required torque(T)	T_A	$T_A + T_S$	
rotary cylinder theoretic torque	T graph 1		

※ Effective torque: to be calculated within 70 % of T theoretic torque in consideration of safety rate.

1J = 0.10197kgf · m = 10.2kgf · cm
1kgf · m = 9.80665J
1N = 0.10197 kgf
1N · m = 0.10197kgf · m = 10.2kgf · cm

4. Calculating the load capacity

Referring to the table of shape, get the inertia moment I.

※ In the case of rectangle

$I = m \times (a^2 + b^2)/12$

I : inertia moment (kgf m2)
m : weight (kgf)
a : horizontal (m)
b : vertical (m)
calculation formula of inertia moment : figure 1

5. Calculating kinetic energy and checking allowed energy

Get the kinetic energy E(J) of loaded object.Get allowed energy Ea(J).
Check to prevent the kinetic energy E(J) of loaded object from exceeding the allowed energy Ea(J).

※ In the case of rectangle

$E = 1/2 \times I \times \omega^2$, $\omega = (2\theta / t)$

E : kinetic energy (J)
I : inertia moment (kgf · m^2)
ω : velocity (rad/s)
θ : revolving angle (rad)
90° = 1.57 rad
180° = 3.14 rad
t : rotation time (s)
allowed energy Emax : table 1
kinetic energy(E)≤ allowed energy(Ea)

※ In the case of attaching shock absorber

weight m_1 : m_1 : (kgf)
$m_1 = I / R2$ I : (kgf · m^2)
R : distance between the center line of revolution to the center of vertical hem shock(m) figure 4

weight m_2
$m_2 = (2 \times T \times L) / (R^3 \times \omega^2)$
$\omega = (2\theta / t)$ m_2 : weight (kgf)
T : effective torque(N · m)
L : stroke of shock absorber(m) figure 4

$m = m_1 + m_2$ ω : angular velocity (rad/s)
calculating the colliding velocity V : velocity(m/s)
$V = R \times \omega$
calculating kinetic energy $E = 1/2 \times m \times V^2$
kinetic energy(E)≤allowed energy(Ea)

6. Load Rate

6-1 load rate of thrust load
Get loadable mass Wr(kg). Get load rate $\alpha 1$ of load mass.

maximum loadable weight Wmax : figure 2
$\alpha_1 = W / W_{T\ MAX}$

6-2 load rate of radial load
Get loadable mass Wr(kg).
Get load rate $\alpha 2$ of load mass.

maximum loadable weight Wmax : figure 2
$\alpha_2 = W / W_{R\ MAX}$

6-3 load rate of bending moment
Get moment M(N.m).
Get allowed moment M_{MAX}(N.m).
Get load rate $\alpha 3$ of static moment.

maximum loadable weight Wmax : figure 2
$\alpha_3 = M / M_{MAX}$
(for NRT series only)

7. The whole sum of total load rate

If the whole sum of load rate does not exceed 1.

Usable depending on $\Sigma\alpha_n = \alpha_1 + \alpha_2 + \alpha_3 \leq 1$

Table 1 classifying system of rotary cylinder series

Type		Model	Cylinder diameter (mm)	Revolving angle (°)	Allowed energy (Kgf.cm)		Theoretic energy (Kgf.cm) (based on P=5Kgf/cm²)	Rotation time based on 90 ° (sec)		Maximum thrust load(Kgf)	Maximum radial load(Kgf)
Rotary Cylinder	Rack & Pinion type	NRP50	50	90	without air cushion	0.475	103	0.2 ~ 2		50	20
				180	with air cushion	8.8					
		NRP63	63	90	without air cushion	1.14	187	0.2 ~ 3		60	30
				180	with air cushion	13.2					
		NRP80	80	90	without air cushion	1.52	377	0.2 ~ 4		90	40
				180	with air cushion	17.6					
		NRP100	100	90	without air cushion	5.225	765	0.2 ~ 5		100	60
				180	with air cushion	26.4					
	Rack & Pinion Compact type	NRC12	10	90	without cushion	0.07	3.1	adjusting bolt attached	0.2~0.7	1.6	1.5
				180	shock absorber attached	0.7		shock absorber attached	0.2~0.5		
		NRC15	13	90	without cushion	0.12	8.0	adjusting bolt attached	0.2~0.7	2	2
				180	shock absorber attached	1.2		shock absorber attached	0.2~0.5		
		NRC20	18	90	without cushion	0.24	19.1	adjusting bolt attached	0.2~1.0	5	5
				180	shock absorber attached	2.5		shock absorber attached	0.2~0.7		
		NRC30	20	90	without cushion	0.46	28.3	adjusting bolt attached	0.2~1.0	10	8
				180	shock absorber attached	3.8		shock absorber attached	0.2~0.7		
	Table type	NRT30	2x∅22	190	adjusting bolt attached	0.49	31.3	adjusting bolt attached	0.2~1.0	37	20
					shock absorber attached	1.041		shock absorber attached	0.2~0.7		
		NRT50	2x∅25	190	adjusting bolt attached	0.78	51.5	adjusting bolt attached	0.2~1.0	46	32
					shock absorber attached	2.639		shock absorber attached	0.2~0.7		
		NRT70	2x∅28	190	adjusting bolt attached	2.33	75.4	adjusting bolt attached	0.2~1.5	49	34
					shock absorber attached	9.68		shock absorber attached	0.2~1.0		
		NRT100	2x∅32	190	adjusting bolt attached	3.10	102.5	adjusting bolt attached	0.2~2.0	72	40
					shock absorber attached	14.08		shock absorber attached	0.2~1.0		

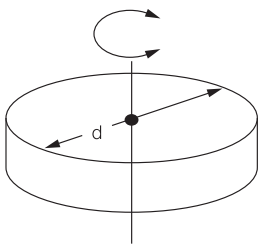
Figure 1 Formula to calculate inertia movement

Classification of Movement (inertia resistance)

Formula of inertia movement can be described by the following expression.

Depending on the shape of inertia movement object, apply the expressions as described in the following figures.

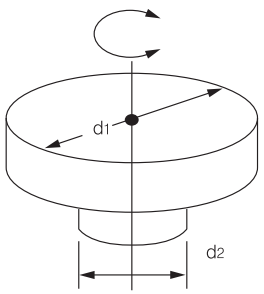
1. Shape of disk on the revolving central line



• diameter d(m)
• weight m(Kgf)

$I = md^2/8$

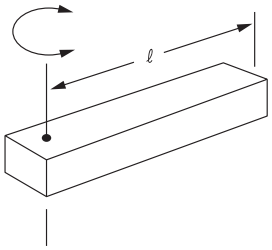
2. Disk of single dimension on the revolving central line



• diameter d_1(m)
d_2(m)
• weight
m_1 : d_1 partial weight (Kgf)
m_2 : d_2 partial weight (Kgf)

$I = (m_1 d_1^2 + m_2 d_2^2)$

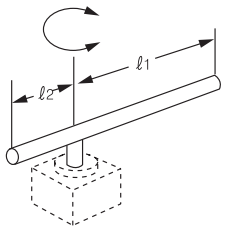
3. Stick



• stick length ℓ (m)
• weight m(Kgf)

$I = m\ell^2/3$

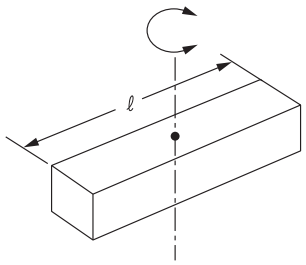
4. Slim Rod



• stick length ℓ_1(m)
ℓ_2(m)
• weight
m_1 : ℓ_1 partial weight (Kgf)
m_2 : ℓ_2 partial weight (Kgf)

$I = (m_1 \ell_1^2 + m_2 \ell_2^2)$

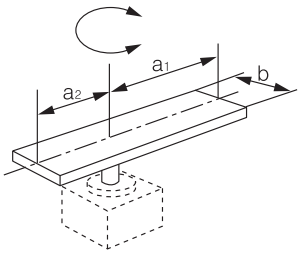
5. Stick on the revolving central line



- stick length ℓ (m)
- weight m(Kgf)

$I = m\ell^2/12$

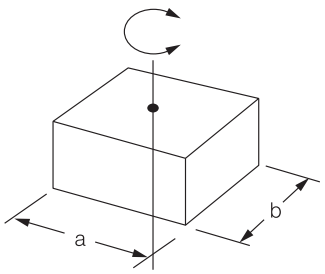
6. Displaced rectangle on the revolving central line



- horizontal a_1(m)
  a_2(m)
- weight
  m_1 : a1×b partial weight (Kgf)
  m_2 : a1×b partial weight (Kgf)

$I=m_1(4a_2^2+b^2)/12+m_2(4a_2^2+b_2^2)/12$

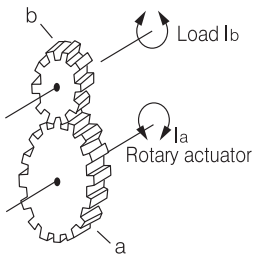
7. Rectangle on the revolving central line



- horizontal a(m)
  vertical b(m)
- weight m(Kgf)

$I = m(a^2 + b^2)/12$

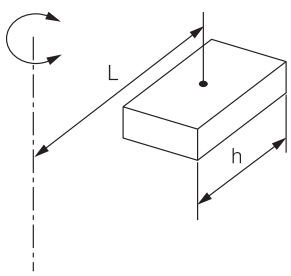
8. In case of toothed wheel combination



- number of toothed wheel : a
- number of toothed wheel : b
- Get the revolving inertia moment Ib on the load axis.
- If replace the revolving inertia moment on the driving axis by Ib to make Ia,

$L= (a/b)^2 * I_b$

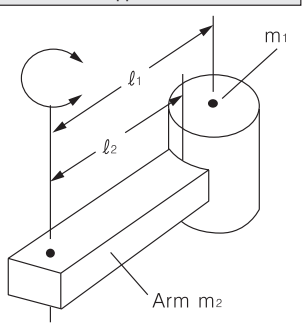
9. In case the revolving axis is at any point of load



- horizontal h(m)
- L : distance from the revolving axis to the center of load (m)
- weight m(Kgf)

$I = (mh^2/12)+mL^2$

10. In case that load is applied to the arm terminal



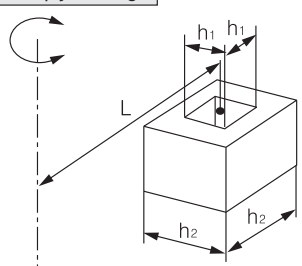
- I1 : inertia moment on the central line of load at vertical hem
- I2 : inertia moment on the revolving axis of Arm part

m1 : weight at the vertical hem(Kgf)
m2 : weight at the arm part(Kgf)
ℓ1 : distance between revolving axis and center of vertical hem load (m)
ℓ2 : distance between revolving axis and center of vertical hem load (m)

$I = m1k^2+m_2\ell_1^2+(m2\ell_1^2)/3$

k : If m_1 is in the shape of disk, $k=d^2/8$, referring to 1.

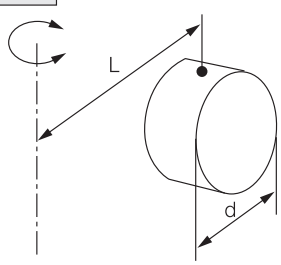
11. Empty Rectangle



- length h1(m)
  h2(m)
- L : distance from the revolving axis to the center of load (m)
- weight m(Kgf)

$I = m/12(h_2^2 + h_2^2) + mL^2$

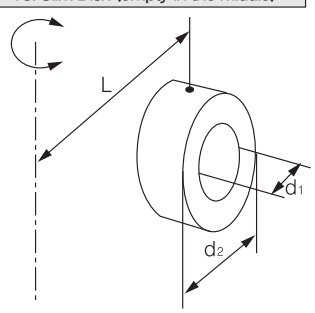
12. Slim Disk



- diameter d(m)
- L : distance from the revolving axis to the center of load (m)
- Weight m(Kgf)

$I = (md^2/16) + mL^2$

13. Slim Disk (empty in the middle)



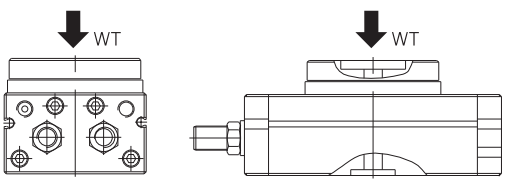
- diameter d1(m)
  d2(m)
- L : distance from the revolving axis to the center of load (m)
- weight m(Kgf)

$I = m/16(d_2^2 + d_1^2) + mL^2$

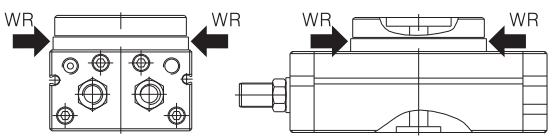
Figure 2 Allowed Axis Load

Model	Series	Type	Thrust Load (Kgf)	Radial Load (Kgf)	Bending Movement N.m(Kgf.cm)
Rack and Pinion Type	NRC Series (double rack)	NRC12	1.6	1.5	–
		NRC15	2	2	–
		NRC20	5	5	–
		NRC30	10	8	–
	NRP Series (single rack)	NRP50	50	20	–
		NRP63	60	30	–
		NRP80	90	40	–
		NRP100	100	60	–
	NRT Series (double rack)	NRT30	37	20	5.3 (54)
		NRT50	46	32	9.7 (99)
		NRT70	49	34	12.0 (122)
		NRT100	72	40	18.0 (184)

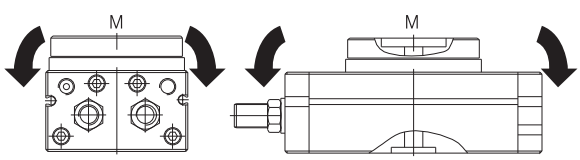
Thrust Load (NRT)



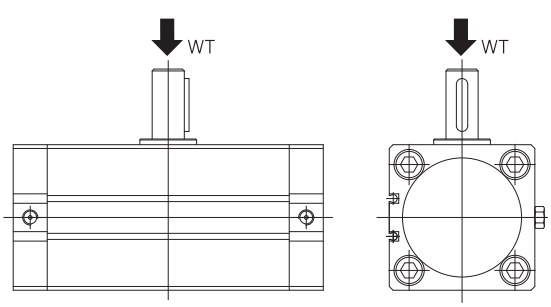
Radial Load (NRT)



Bending Movement Load (NRT)



Thrust Load (NRP, NRC)



Radial Load (NRP, NRC)

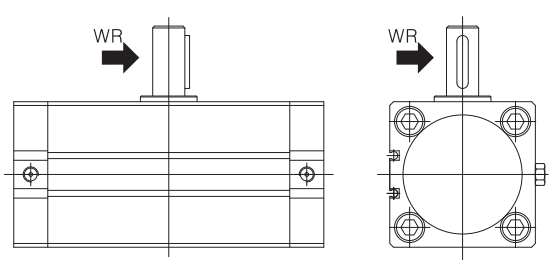
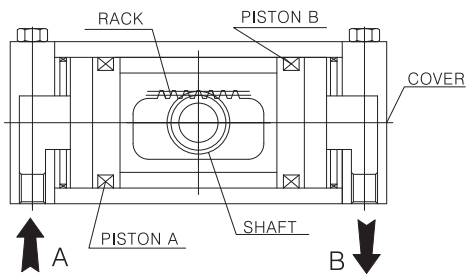
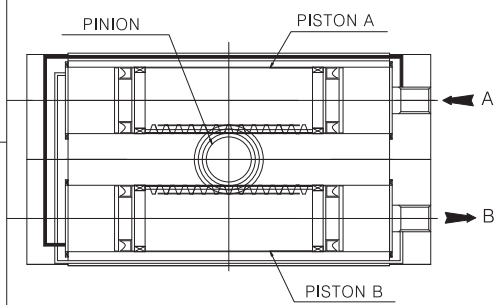
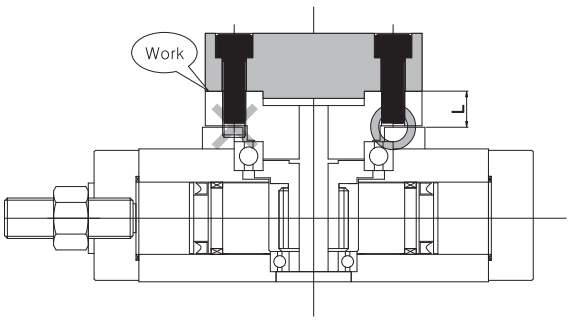


Figure 3 Operation Principle

Series		Operating Principle	Explanation
Rack & Pinion Type	NRP		1. This equipment is composed of two pistons which move inside the cylinder, contacting the cylinder and rack/shaft which is inserted into the piston. 2. If air is supplied through A port, piston A is pressed and torque generates at shaft through rack pinion. 3. Air in the draining chamber is drained through B port and revolves clockwise. 4. If piston B contacts cover and stops, shaft also stops. 5. If air is supplied through B port, it also revolves counterclockwise.
Rack & Pinion Compact Type	NRC		1. This equipment is composed of rack which moves inside two parallel cylinders, contacting them and 2 pistons and pinion in one body. 2. If air is supplied through A port, the right side of piston A is pressed and simultaneously the left side of piston B is also pressed through the air passage of main body. Then, torque in the quantity of 2 pistons generates at pinion. 3. Air in the draining chamber is drained through B port and revolves counterclockwise. 4. If piston B contacts adjusting bolt and stops, pinion also stops. 5. If air is supplied through B port, it also revolves clockwise.
Table Type	NRT		

How to mount rotary cylinder

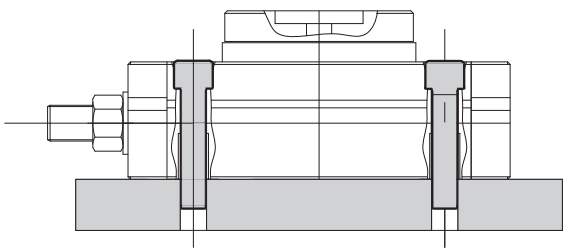
How to mount NRT series



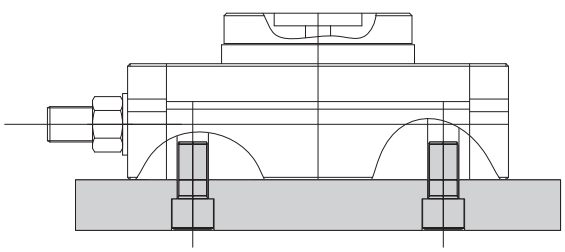
Model	Bolt	Maximum fastening torque M(Kgf*cm)	Maximum tightening depth L
NRT30	M6 × 1	7.4 (73)	10
NRT50	M8 × 1.25	17.3 (170)	12
NRT70	M8 × 1.25	17.3 (170)	12.5
NRT100	M10 × 1.5	35.7 (350)	14.5

There are 2 attaching methods for rotary cylinder NRT series as described in the following figures.
The tightening torque must comply with the following table.

※ fastening method through hole

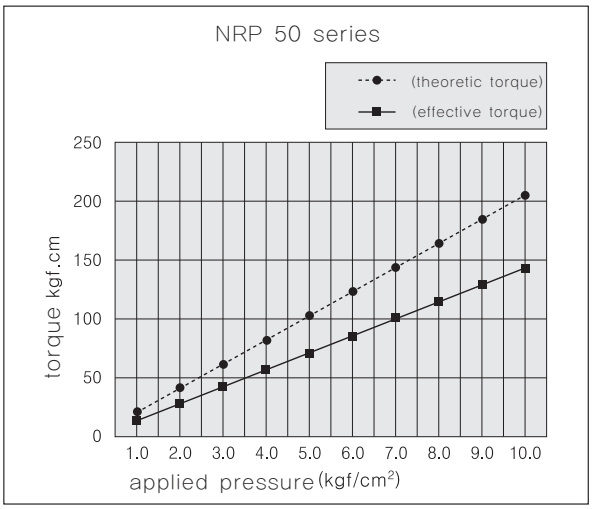


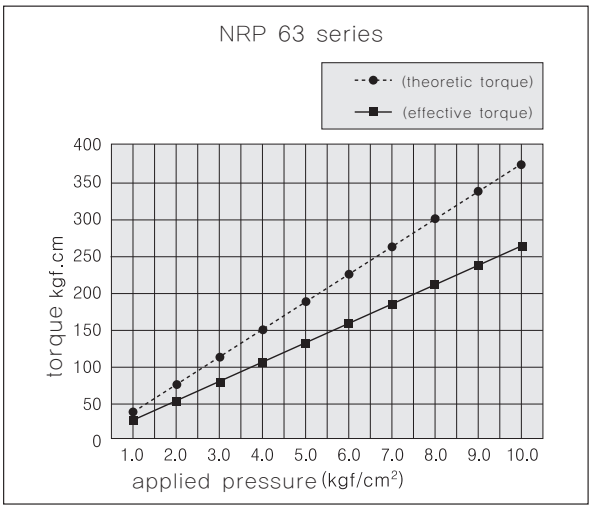
※ fastening method through TAP part (female screw)

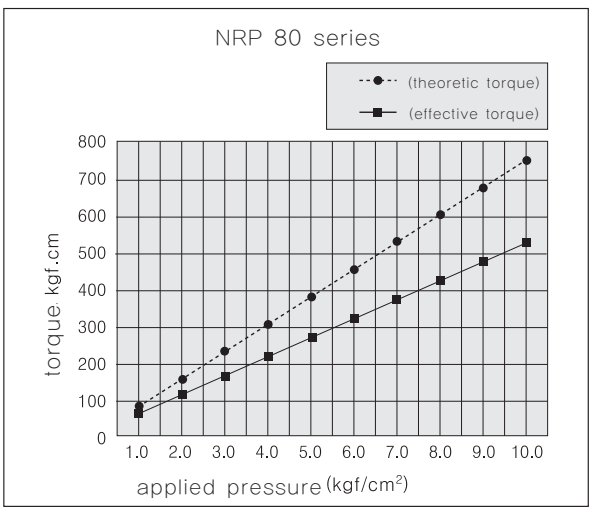


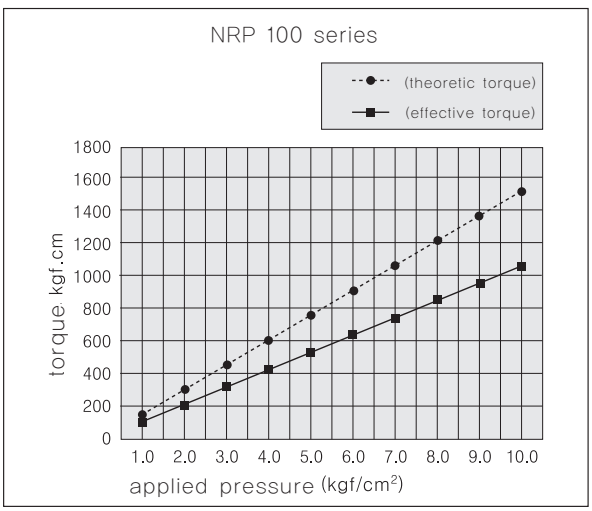
Model	Fastening method	Bolt	Maximum fastening torque N*m (Kgf*cm)
NRT30	through hole	M8 × 1.25	17.3 (170)
	female screw	M10 × 1.5	35.7 (350)
NRT50	through hole	M10 × 1.5	35.7 (350)
	female screw	M12 × 1.75	61.2 (600)
NRT70	through hole	M10 × 1.5	35.7 (350)
	female screw	M12 × 1.75	61.2 (600)
NRT100	through hole	M10 × 1.5	35.7 (350)
	female screw	M12 × 1.75	61.2 (600)

NRP Series

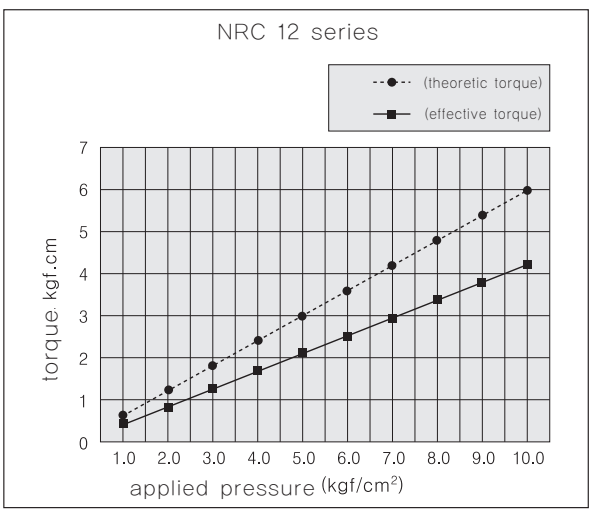


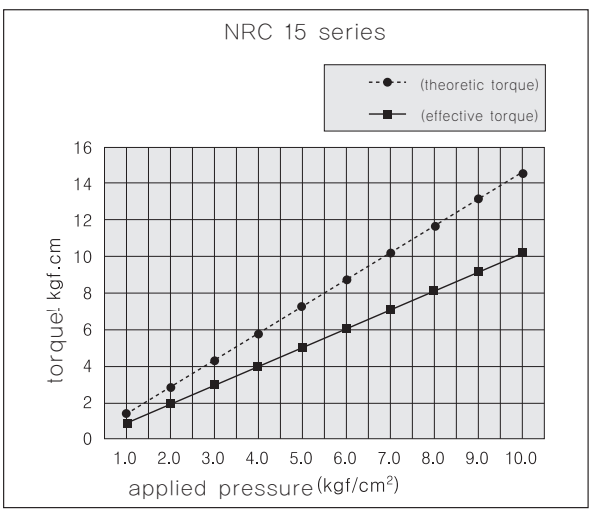




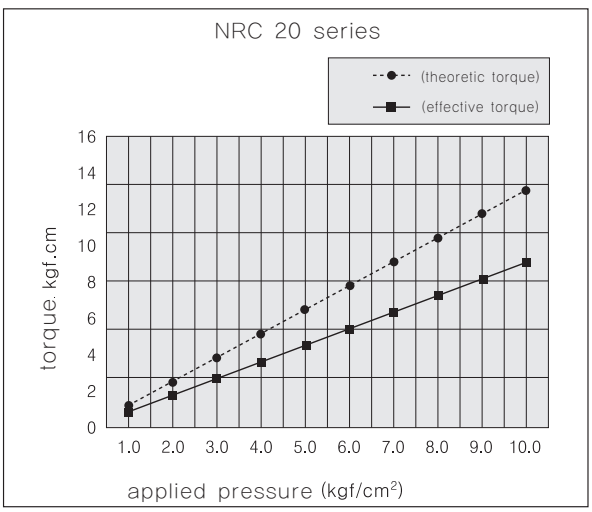


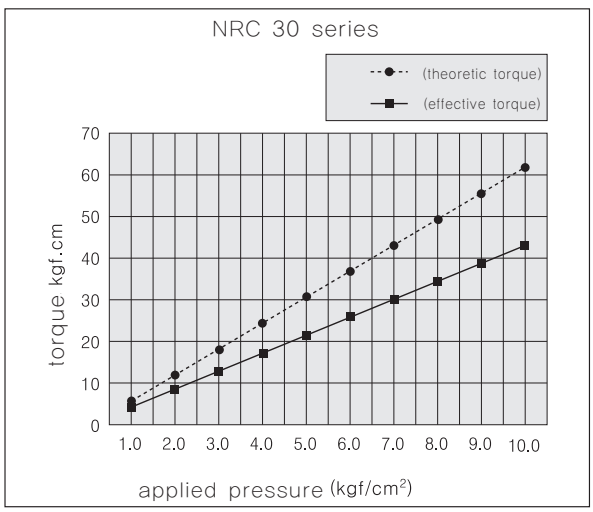
NRC Series



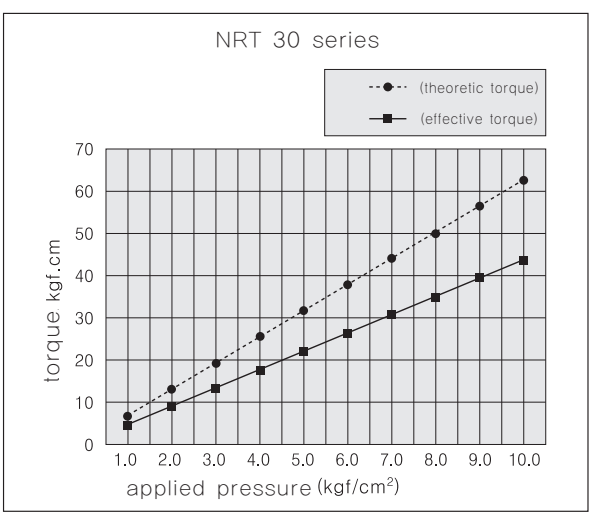


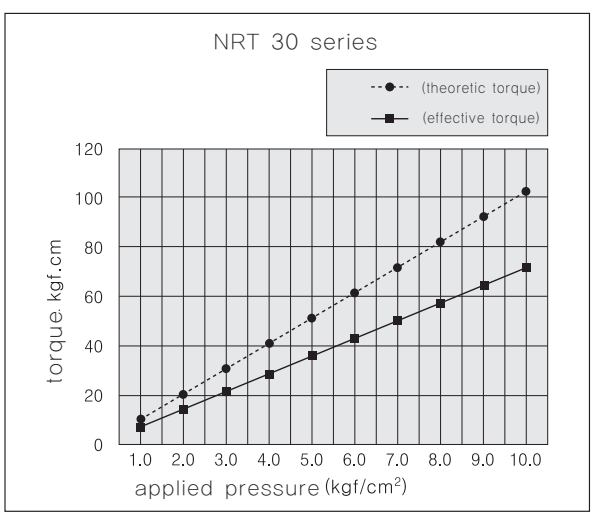
NRC Series

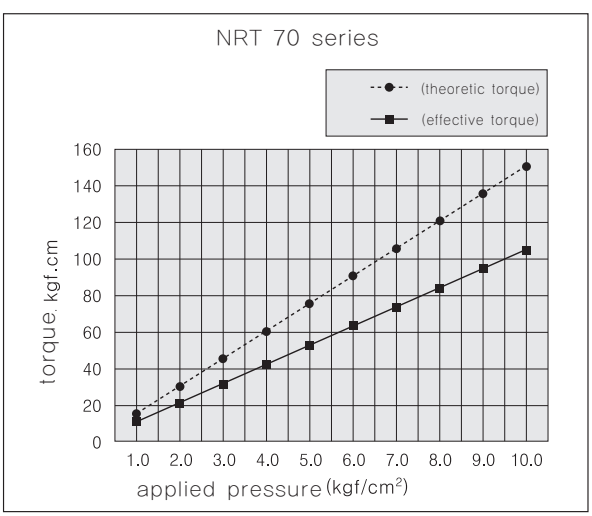




NRT Series







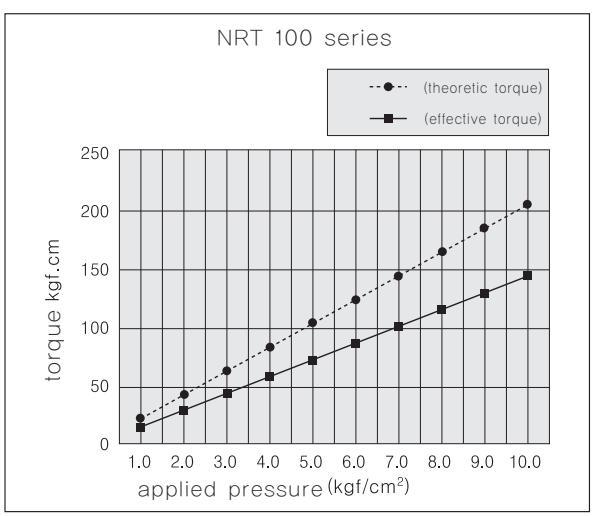
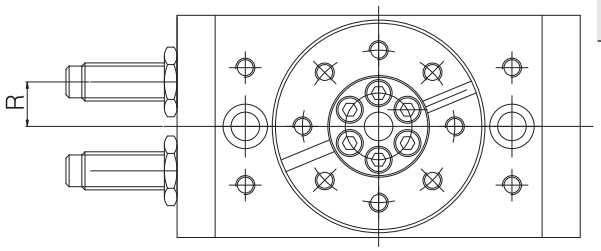


Figure 4

1. Shock absorber stroke and distance

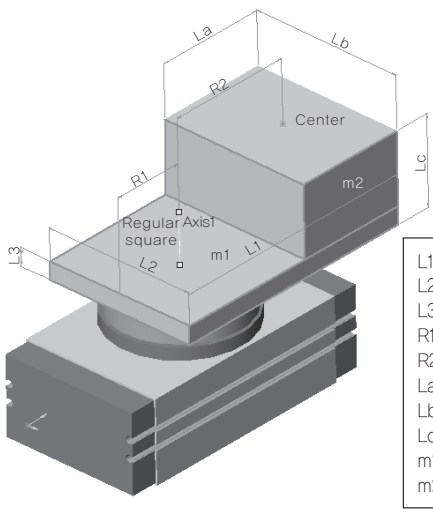


R : distance from the revolving central line to the shock center at vertical hem

Type		Model	R (m)	Shock absorber stroke(m)	Shock absorber spec
Rotary Cylinder	rack & pinion compact type	NRC12	0.01	0.005	M8 × 0.75
		NRC15	0.014	0.005	M8 × 0.75
		NRC20	0.016	0.006	M10 × 1.0
		NRC30	0.0195	0.006	M12 × 1.0
	table type	NRT30	0.014	0.006	M12 × 1.0
		NRT50	0.019	0.01	M14 × 1.5
		NRT70	0.021	0.015	M20 × 1.5
		NRT100	0.025	0.015	M20 × 1.5

Example (on the basis of NRT type)

In a case where a plate is attached to the revolving axis and assembled to the terminal plate in regular square type :



L1 : 0.12m
L2 : 0.05m
L3 : 0.01m
R1 : 0.025m
R2 : 0.07m
La : 0.05m
Lb : 0.05m
Lc : 0.05m
m1 : square plate
m2 : regular square

1. Applying Condition
   ① revolving angle : 90 °
   ② rotation time : 0.5 second
   ③ applied pressure : 0.5 (Mpa)
   ④ shape: Refer to the above figure.
   Quality of the material of plate : aluminum alloy
   (specific gravity=2.68 × 103 Kg/ ㎥)
   Quality of the material of regular square : steel for structure
   (specific gravity=7.85 × 103 Kg/ ㎥)
   ⑤ attaching direction : horizontal

2. Checking Rotation Time

Rotation time is 0.5 second.(on the basis of 90 °) Thus, as rotation time is between 0.2~1.0 second, it can be used without problem.

3. Selecting Torque

Calculating inertia moment :

Weight of plate

$m_1 = L2 \times (L1-R1) \times L3 \times 2.68 \times 10^3$
$= 0.05 \times (0.12-0.025) \times 0.01 \times 2.68 \times 10^3 = 0.127$ (kgf)
$m_2 = L2 \times R1 \times L3 \times 2.68 \times 10^3$
$= 0.05 \times 0.025 \times 0.01 \times 2.68 \times 10^3 = 0.034$ (kgf)
$I_1 = 0.127/12\{4 \times (0.12-0.025)^2 + 0.05^2\} + 0.034/12\{4 \times 0.025^2 + 0.05^2\}$
$= 0.42 \times 10^{-3}$ (kg.m²) ————①

Weight of regular square

$m_3 = La \times Lb \times Lc \times 2.68 \times 10^3$
$= 0.05 \times 0.05 \times 0.05 \times 2.68 \times 10^3 = 0.335$ (kgf)

$I_2 = (0.335 \times 0.05^2)/12 + (0.335 \times 0.07^2)$
$= 1.71 \times 10^{-3}$ (kg. m²) ————②

Get the actual inertia moment I.
$I = I_1 + I_2$
$= 0.42 \times 10^{-3} + 1.71 \times 10^{-3}$
$= 2.13 \times 10^{-3}$ (kg. m²)————③

According to the condition, θ=90 ° , t=0.5 second Thus, each acceleration wa is calculated by the following expression.

$\omega_A = (2 \times 1.57)/ 0.5^2 = 12.56$ (rad/s²) ————④

Substituting expression ③,④ limit coefficient: over 5 times is applied to accelerating torque.

Accelerating torque $TA = I \times \omega_A \times K = 5.43 \times 10^{-3} \times 12.56$ (rad/s²) × 5 = 0.134 (N.m) ——⑤

Referring to the table of theoretic torque
If torque of 0.134 N.m (1.37 Kgf.cm) is necessary when applied pressure is 0.5 MPa (5 Kg/㎠), the supplying pressure is extended to horizontal axis and torque, to vertical axis respectively to get the intersection. Inner diameter larger than this intersection is to be selected.

※ Rotary cylinder: For NRT30, theoretic torque is
T=31.3 Kgf.cm
Effective torque: to be calculated within 70 % of the theoretic torque.
T ≒ 21.9 Kgf.cm

4. Inspecting kinetic energy

When a urethane stopper is installed
According to the condition, θ=90 °, t = 0.5 second
ω = (2 × 1.57)/ 0.5 = 6.28 (rad/s) ————①
From the expression ①, kinetic energy E is
E = 1/2 × 2.13 × 10 -3 × 6.282 = 0.042 (J) ——— ②
0.042 < 0.048 (0.49 Kgf.cm)it can be used with no problem in installation.
In case that allowed energy is exceeded, use buffer such as shock absorber, etc.

When shock absorber is installed

m1 = (2.13 × 10-3)/0.0142 = 10.87(Kgf) ————③
m2 = (2 × 0.134 × 0.006)/(0.0143 × 6.282)
= 14.86(Kgf) ————④

From expressions ③, ④
m = 10.87 + 14.86 = 25.73 (Kg) ————⑤
v = 0.014 × 6.28 = 0.088—— ————⑥
From expressions ⑤, ⑥ If the expression of kinetic energy is substituted from the expressions (5),(6) E = (25.73 × 0.0882)/ 2 = 0.0996 (J)
As 0.0996 < 0.106 (1.041 Kgf.cm), it can be used with no problem in installing shock absorber.

5. Inspecting load rate

Thrust load
Total weight : 0.127 + 0.034 + 0.335 = 0.496 (KG)
Thus, WT = 0.496 × 9.8 = 4.86 (N) ————①
Radial load
As there is no applied load WR = 0 (N) ————②
Moment
The movement of plate is,
M1 = (0.127 + 0.034) × 9.8 × { (0.12/2) − 0.025 } = 0.055 (N.m) ——③

The movement of regular square is
M2 = 0.335 × 9.8 × 0.07 = 0.23 (N.m) ——④
From the expressions ③, ④ the total moment value is,
M = 0.055 + 0.23 = 0.285 (N.m)————⑤

From expressions ①, ②, and ⑤ the value of total load rate is,

(WT / WT MAX)+(WS / WS MAX)+(M / M MAX)=4.86/363+0/197+0.285/5.3 = 0.0672 < 1.0

If the total of load rate does not exceed 1, it can be used.

6. Selection

NRT 30 can be used, because it is within the requirement of kinetic energy and load rate.

Air consumption of rotary cylinder

ℓ /min(ANR)

Model		Cylinder diameter · cm(in)	PCD · cm(in)	Cylinder stroke · cm(in)	Internal volume	Pressure · Kgf/㎠(psi)									
						1	2	3	4	5	6	7	8	9	10
NRC series (double rack)	NRC12-90°	1(0.39)	1.05(0.41)	0.82(0.32)	0.65	0.01(0.14)	0.03(0.42)	0.04(0.57)	0.05(0.71)	0.07(0.99)	0.08(1.13)	0.09(1.28)	–	–	–
	NRC12-180°	1(0.39)	1.05(0.41)	1.65(0.65)	1.29	0.03(0.42)	0.05(0.71)	0.08(1.13)	0.10(1.42)	0.13(1.85)	0.16(2.27)	0.18(2.56)	–	–	–
	NRC15-90°	1.3(0.51)	1.65(0.65)	1.30(0.51)	1.72	0.04(0.57)	0.07(0.99)	0.11(1.56)	0.14(1.99)	0.17(2.41)	0.21(2.98)	0.24(3.41)	–	–	–
	NRC15-180°	1.3(0.51)	1.65(0.65)	2.59(1.02)	3.44	0.07(0.99)	0.14(1.89)	0.21(2.98)	0.28(3.98)	0.35(4.98)	0.41(5.83)	0.48(6.82)	–	–	–
	NRC20-90°	1.8(0.71)	1.55(0.61)	1.22(0.48)	3.09	0.07(0.99)	0.13(1.99)	0.19(2.70)	0.25(3.55)	0.31(4.41)	0.37(5.26)	0.43(6.11)	–	–	–
	NRC20-180°	1.8(0.71)	1.55(0.61)	2.43(0.95)	6.19	0.13(1.85)	0.26(1.85)	0.38(5.40)	0.50(7.11)	0.62(8.81)	0.75(10.66)	0.87(12.37)	–	–	–
	NRC30-90°	2(0.79)	1.75(0.69)	1.37(0.54)	4.31	0.09(1.28)	0.18(3.70)	0.26(3.70)	0.35(4.98)	0.43(6.11)	0.52(7.39)	0.60(8.53)	–	–	–
	NRC30-180°	2(0.79)	1.75(0.69)	2.75(1.08)	8.63	0.19(2.70)	0.36(2.56)	0.53(7.54)	0.70(9.95)	0.87(12.37)	1.04(14.79)	1.21(17.21)	–	–	–
NRP series (single rack)	NRP50-90°	5(1.97)	2.1(0.82)	1.65(0.65)	32.35	0.70(1.95)	1.34(5.12)	1.98(28.16)	2.62(37.26)	3.26(51.5)	3.90(55.4)	4.54(64.5)	5.17(73.5)	5.81(82.6)	6.45(91.7)
	NRP50-100°	5(1.97)	2.1(0.82)	1.83(0.72)	35.95	0.78(11.09)	1.49(19.06)	2.20(31.3)	2.91(141.4)	3.62(92.7)	4.33(61.6)	5.04(71.7)	5.75(81.8)	6.46(91.9)	7.17(102)
	NRP50-180°	5(1.97)	2.1(0.82)	3.30(1.30)	64.70	1.4(20.0)	2.68(21.19)	3.96(56.3)	5.24(74.5)	6.52(92.7)	7.79(110)	9.07(129)	10.35(147)	11.63(165)	12.90(183)
	NRP50-190°	5(1.97)	2.1(0.82)	3.48(1.37)	68.30	1.49(21.2)	2.83(40.2)	4.18(59.4)	5.53(78.6)	6.88(97.8)	8.23(117)	9.58(136)	10.92(155)	12.27(174)	13.62(193)
	NRP63-90°	6.3(2.48)	2.4(0.94)	1.88(0.74)	58.70	1.28(18.2)	2.44(34.7)	3.59(51.0)	4.75(67.5)	5.91(84.0)	7.07(100)	8.23(117)	9.39(133)	10.55(150)	11.71(166)
	NRP63-100°	6.3(2.48)	2.4(0.94)	2.09(0.82)	65.22	1.42(20.2)	2.71(38.5)	3.99(56.7)	5.28(75.1)	6.57(93.4)	7.86(111)	9.14(130)	10.43(148)	11.72(166)	13.01(185)
	NRP63-180°	6.3(2.48)	2.4(0.94)	3.77(1.48)	117.40	2.55(30.2)	4.87(69.2)	7.19(102)	9.51(135)	11.82(168)	14.14(201)	16.46(234)	18.78(267)	21.10(300)	23.41(333)
	NRP63-190°	6.3(2.48)	2.4(0.94)	3.98(1.56)	123.92	2.69(38.2)	5.14(77.5)	7.59(108)	10.03(142)	12.48(177)	14.93(212)	17.37(247)	19.82(282)	22.27(316)	24.71(351)
	NRP80-90°	8(3.15)	3(1.18)	2.36(0.93)	118.32	2.57(36.2)	4.91(69.8)	7.24(103)	9.58(136)	11.92(169)	14.25(202)	16.59(236)	18.92(269)	21.26(302)	23.60(335)
	NRP80-100°	8(3.15)	3(1.18)	2.62(1.03)	131.46	2.86(40.6)	5.45(73.1)	8.05(114)	10.64(151)	13.24(188)	15.84(225)	18.43(262)	21.03(299)	23.62(336)	26.22(373)
	NRP80-180°	8(3.15)	3(1.18)	4.71(1.85)	236.63	5.15(73.2)	9.82(69.8)	14.49(206)	19.16(272)	23.83(339)	28.50(405)	33.18(472)	37.85(538)	42.52(604)	47.19(671)
	NRP80-190°	8(3.15)	3(1.18)	4.97(1.95)	249.78	5.43(77.2)	10.36(77.5)	15.29(217)	20.23(287)	25.16(358)	30.09(428)	35.02(498)	39.95(568)	44.88(638)	49.81(708)
	NRP100-90°	10(3.94)	3.9(1.53)	3.06(1.20)	240.33	5.23(74.3)	9.97(139)	14.72(209)	19.46(276)	24.21(344)	28.95(411)	33.69(479)	38.44(564)	43.18(614)	47.93(681)
	NRP100-100°	10(3.94)	3.9(1.53)	3.40(1.34)	267.03	5.81(82.6)	11.08(147)	16.35(232)	21.62(307)	26.89(382)	32.17(457)	37.44(532)	42.71(607)	47.98(682)	53.25(757)
	NRP100-180°	10(3.94)	3.9(1.53)	6.12(2.41)	480.66	10.45(148)	19.94(142)	29.43(418)	38.92(553)	48.41(688)	57.90(823)	67.39(958)	76.88(1093)	86.37(1228)	95.86(1363)
	NRP100-190°	10(3.94)	3.9(1.53)	6.46(2.54)	507.36	11.03(156)	21.05(157)	31.07(442)	41.08(584)	51.10(727)	61.12(869)	71.13(1011)	81.15(1154)	91.17(1296)	101.18(1439)
NRT series (double rack)	NRT30-190°	2.2(0.86)	1.65(0.65)	2.73(1.07)	20.78	0.90(12.8)	1.72(24.4)	2.54(36.1)	3.36(47.8)	4.19(59.6)	5.01(71.2)	5.83(82.9)	6.65(94.6)	7.47(106)	8.29(118)
	NRT50-190°	2.5(0.98)	2.1(0.82)	3.48(1.37)	34.15	1.49(21.2)	2.83(40.2)	4.18(59.4)	5.53(78.6)	6.88(97.8)	8.23(117)	9.58(136)	10.92(155)	12.27(174)	13.62(193)
	NRT70-190°	2.8(1.10)	2.45(0.96)	4.06(1.60)	49.98	2.17(30.8)	4.15(59)	6.12(87)	8.09(115)	10.07(143)	12.04(171)	14.01(199)	15.99(227)	17.96(259)	19.93(283)
	NRT100-190°	3.2(1.26)	2.55(1.0)	4.23(1.66)	67.94	2.95(41.9)	5.64(80.2)	8.32(118)	11.00(156)	13.69(194)	16.37(233)	19.05(271)	21.73(309)	24.42(347)	27.10(385)

Calculation of air fluid quantity and air consumption

Air consumption (Q) for one cycle of each rotary cylinder is indicated in table 1-6, which will be helpful for your calculation. The air fluid quantity and air consumption is calculated by the following expression.

● To get air fluid quantity (in the case of F.R.L , etc. are selected)

Q1=(3.14D^2/4)*L*60/t*(P+1.013)/1.013*10^-3

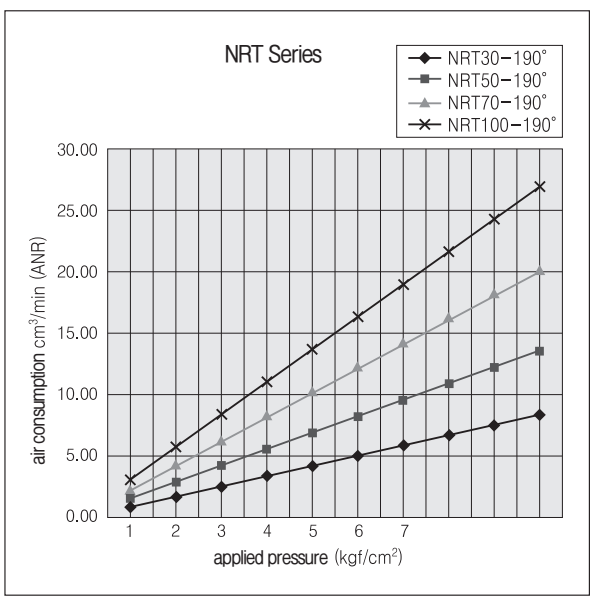
or Q1=q*60/t*(P+1.013)/1.013*10^-3

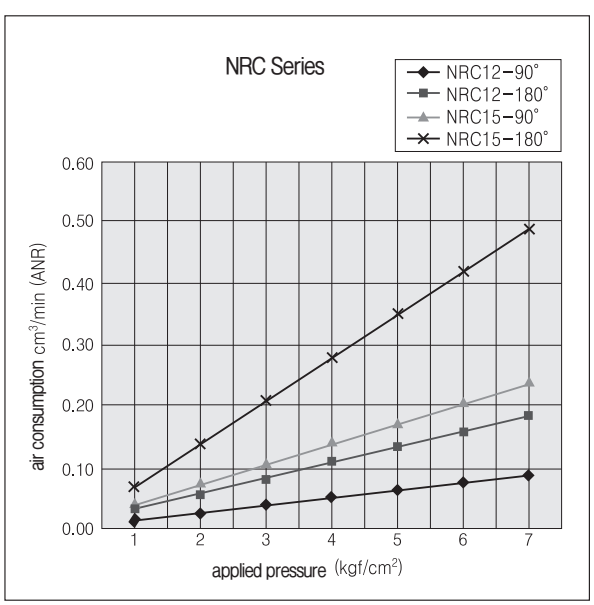
● To get air consumption

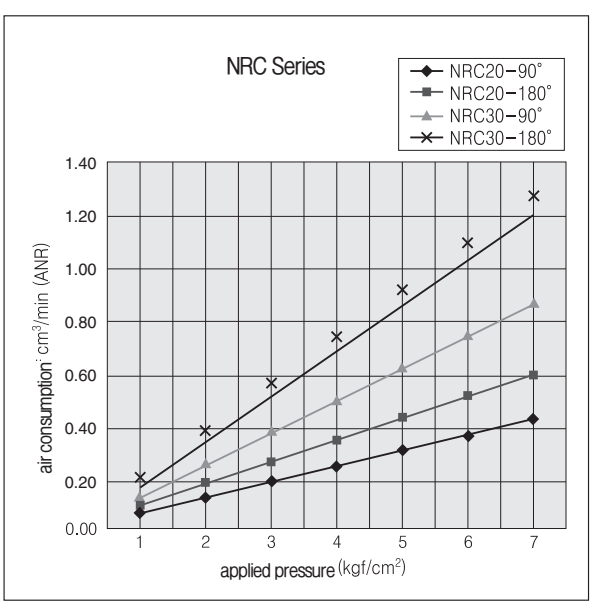
Q2=(3.14D^2/4)*L*2*n*(P+1.013)/1.013*10^-3

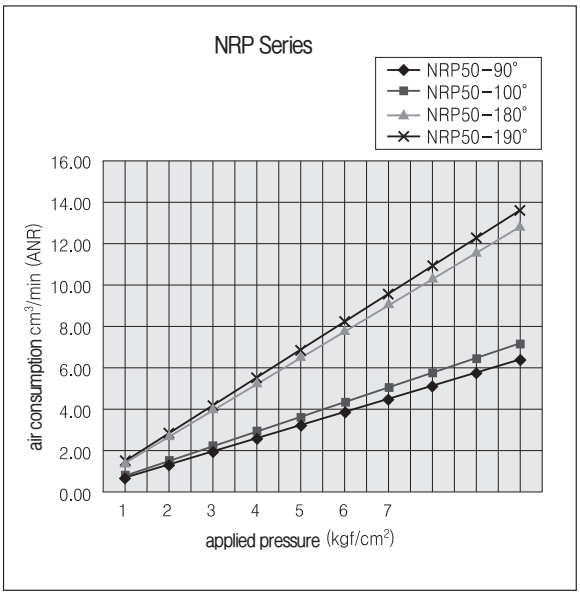
or Q2=q*2*n*(P+1.013)/1.013*10^-3

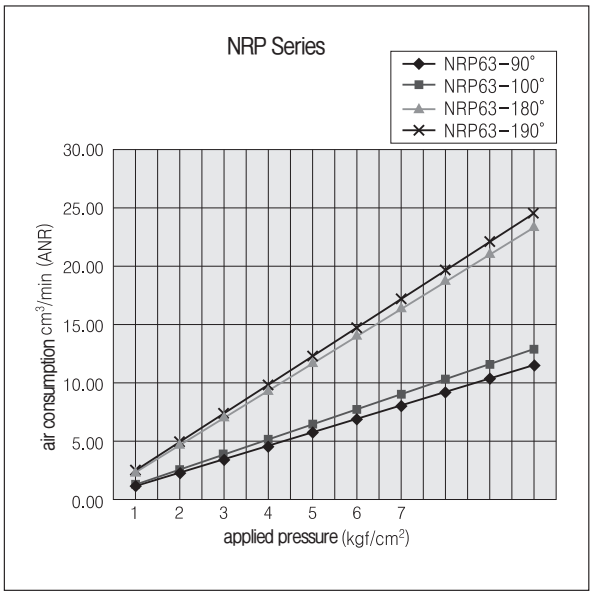
Q1 : air fluid quantity ℓ /min (ANR)
Q2 : air fluid consumption ℓ /min (ANR)
D : inner diameter of cylinder tube cm
L : cylinder stroke cm
q : inner volume of cylinder (one cylinder only) : cm^3
t :time required for one going and returning of cylinder S
n : number of shaking per minute times/min
P : applied pressure Kgf/cm^2

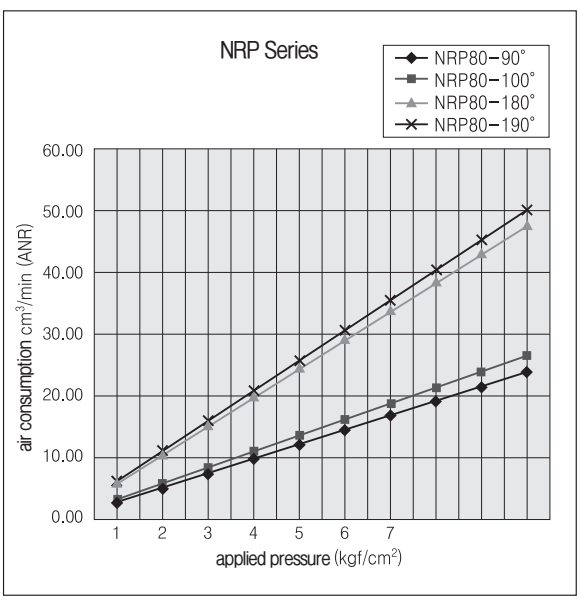


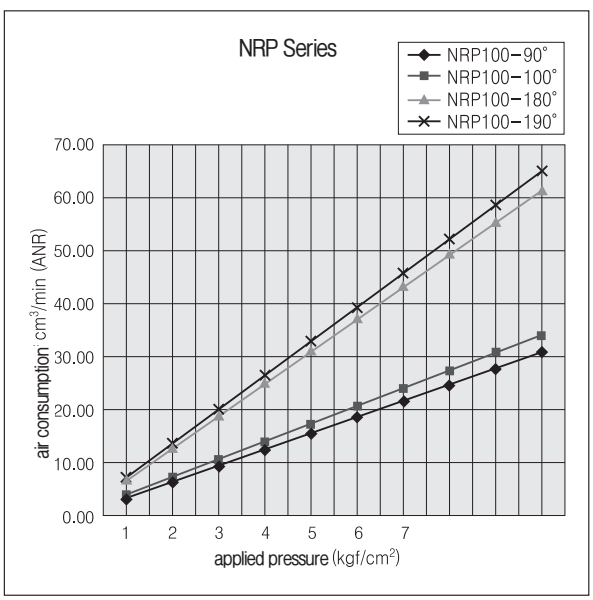






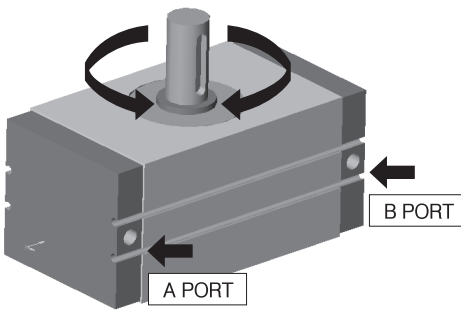




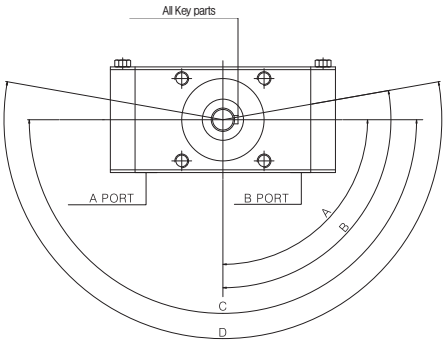


Rotating direction and angle range

1.1 Rotating direction of NRP series: If pressed at A port, the axis revolves clockwise and if pressed at B port, counterclockwise.



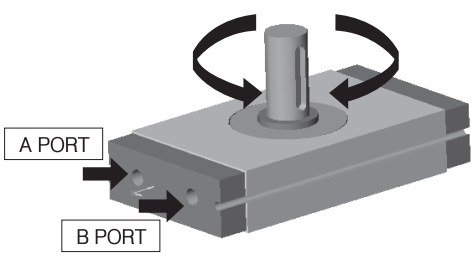
1.2 Angle range of NRP series



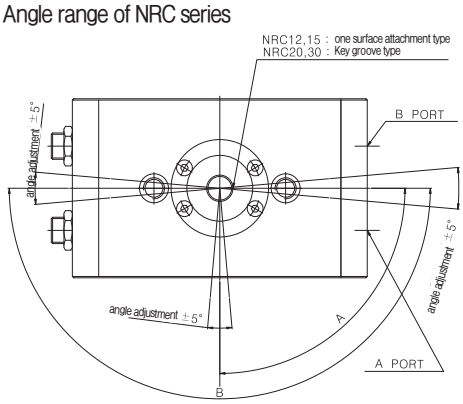
A : Revolving angle of Key groove 90° $^{+4°}_{0}$
B : Revolving angle of Key groove 100° $^{+4°}_{0}$
C : Revolving angle of Key groove 180° $^{+4°}_{0}$
D : Revolving angle of Key groove 190° $^{+4°}_{0}$

※ 90°, 180° : standard specification, 100°, 190° : substandard specification.

1.3 Rotating direction of NRC series : If pressed at A port, the axis revolves clockwise and if pressed at B port, counterclockwise.



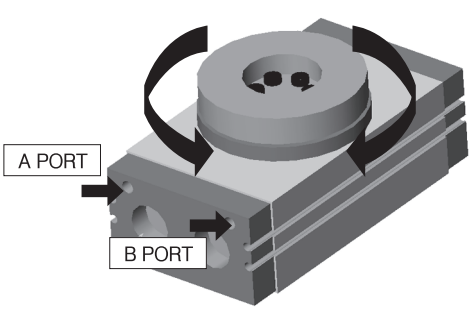
1.4 Angle range of NRC series



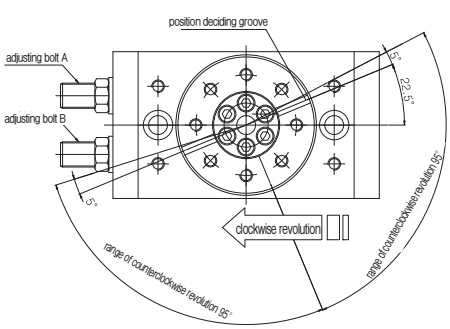
A : shaking angle of Key groove 80° ~100°
B : shaking angle of Key groove 170° ~190°

※ The range of angle adjustment is ±5°.

1.5 Rotating direction of NRT series : If pressed at A port, the axis revolves clockwise and if pressed at B port, counterclockwise.



1.6 Angle range of NRT series



※ The maximum rotation range is 190°. Using shock absorber at angle adjusting part, shock absorber attaching type can receive kinetic energy of 2~5 times to that of adjusting bolt attachment.