Simple and friendly

Kawasaki

Kawasaki Robot
BA013

Installation and Connection Manual

Robot

Kawasaki Heavy Industries, Ltd.

90202-1272DEB

Preface

This manual describes installation and connection procedures for Kawasaki Robot BA013.

Read and understand the contents of this and the separate “Safety Manual” thoroughly and strictly observe all rules for safety before proceeding with any operation. Kawasaki cannot take any responsibility for any accidents and/or damages caused by operations that are based on only the limited part of this manual.

This manual describes only the installation and connection of the Robot Arm. Please refer to the following manual for installation and connection of Controller and for Arc-welding Robots.

“Installation and Connection Manual” for controller
“Installation and Connection Manual” for arc welding

This manual is applicable to the following robot arms.
BA013N, BA013L

1. This manual does not constitute a guarantee of the systems in which the robot is utilized. Accordingly, Kawasaki is not responsible for any accidents, damages, and/or problems relating to industrial property rights as a result of using the system.
2. It is recommended that all personnel assigned for activation of operation, teaching, maintenance or inspection of the robot attend the necessary education/training course(s) prepared by Kawasaki, before assuming their responsibilities.
3. Kawasaki reserves the right to change, revise, or update this manual without prior notice.
4. This manual may not, in whole or in part, be reprinted or copied without the prior written consent of Kawasaki.
5. Store this manual with care and keep it available for use at any time. If the robot is reinstalled or moved to a different site or sold off to a different user, attach this manual to the robot without fail. In the event the manual is lost or damaged severely, contact Kawasaki.

Symbols

The items that require special attention in this manual are designated with the following symbols.

Ensure proper and safe operation of the robot and prevent physical injury or property damages by complying with the safety matters given in the boxes with these symbols.

⚠ DANGER

Failure to comply with indicated matters can result in imminent injury or death.

⚠ WARNING

Failure to comply with indicated matters may possibly lead to injury or death.

⚠ CAUTION

Failure to comply with indicated matters may lead to physical injury and/or mechanical damage.

[NOTE]

Denotes precautions regarding robot specification, handling, teaching, operation, and maintenance.

⚠ WARNING

1. **The accuracy and effectiveness of the diagrams, procedures, and detail explanations given in this manual cannot be confirmed with absolute certainty. Accordingly, it is necessary to give one's fullest attention when using this manual to perform any work. Should any unexplained questions or problems arise, please contact Kawasaki.**
2. **Safety related contents described in this manual apply to each individual work and not to all robot work. In order to perform every work in safety, read and fully understand the separate "Safety Manual," all pertinent laws, regulations and related materials as well as all the safety explanations described in each chapter, and prepare safety measures suitable for actual work.**

Table of Contents

1 Precautions

1.1 Precautions during Transportation, Installation and Storage

When transporting the Kawasaki Robot to its installation site, strictly observe the following cautions.

⚠ WARNING

1. **When the robot arm is to be transported by using a crane or forklift, never allow a person to support it.**
2. **During transportation, never allow a person to ride on the robot arm or stay under the hoisted robot arm.**
3. **Prior to installation, turn OFF the controller power switch and the external power switch for shutting down power supply to the controller. Display signs indicating clearly "Installation and connection in progress," and lock out/tag out the external power switch to prevent accidents of electric shock etc. caused when someone accidentally turns ON the power.**
4. **Prior to moving robot, ensure safety by first confirming no abnormality is observed in installing condition, etc., and then turn ON motor power to set robot to the desired pose. Be careful not to be caught by any moving parts due to careless approach to robot and peripheral equipment. After setting robot to the specified pose, turn OFF the controller power and the external power switch again as mentioned above. Display signs indicating clearly "Installation and connection in progress," and lock out/tag out the external power switch before starting installation and connection.**

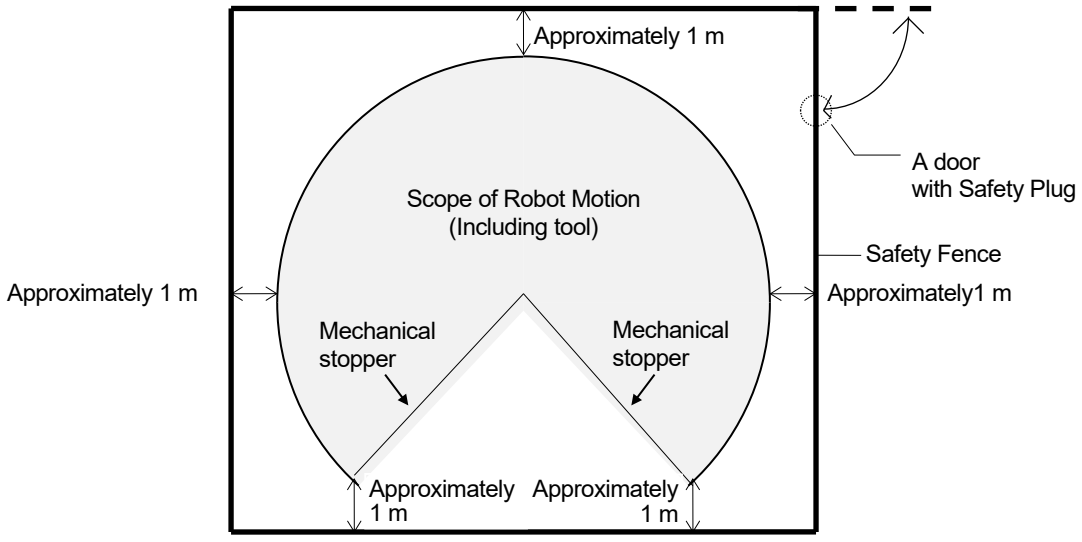
⚠ CAUTION

1. **Since the robot arm is composed of precision parts, be careful not to apply excessive shocks or vibrations during transportation.**
2. **Prior to installation, remove all obstacles so the installation is carried out smoothly and safely. Clear a passage to the installation area for transportation of the robot arm using a crane or forklift.**
3. **During transportation and storage,**
   - **(1) Keep the ambient temperature within the range of -10 to 60°C,**
   - **(2) Keep the relative humidity within the range of 35 to 85% RH without dew condensation,**
   - **(3) Keep free from excessively strong vibration.**

1.2 Installing Environment of Robot Arm

The robot arm must be installed in a place that satisfies all the following environmental conditions:

1. When robot is installed on the floor, the levelness must be within ±5°.
2. Be sure that the installation floor/pedestal has sufficient rigidity.
3. Secure a flatness to prevent undue force applied to the installation section. (If sufficient flatness is unobtainable, insert liners and adjust the flatness.)
4. Keep the ambient temperature during operation within the range of 0 to 45°C. (Deviation or overload error may occur due to high viscosity of grease/oil when starting operation at low temperatures. In this case, move the robot at low speed before regular operation.)
5. Keep the relative humidity during operation within the range of 35 to 85% RH without dew condensation.
6. The robot installing place should be free from dust, dirt, oil, smoke, water, and other foreign matters.
7. The robot installing place should be free from flammable or corrosive liquid or gas.
8. The robot installing place should be free from excessively strong vibration. (0.5 G or less)
9. The robot installing place should be free from electric noise interference.
10. The robot installing place should be sufficiently larger than the motion range of robot arm.
    (1) Install a safety fence around the robot, and make sure that it does not interfere with surrounding equipment, even when the arm has a hand or gun attached and is extended to its maximum motion range.
    (2) Minimize the number of entrance gates (only one is best) and equip the entrance gate with a safety plug.
    (3) Observe the requirements of ISO 10218, established in each region for details of the safety fence.



1.3 Warning Label

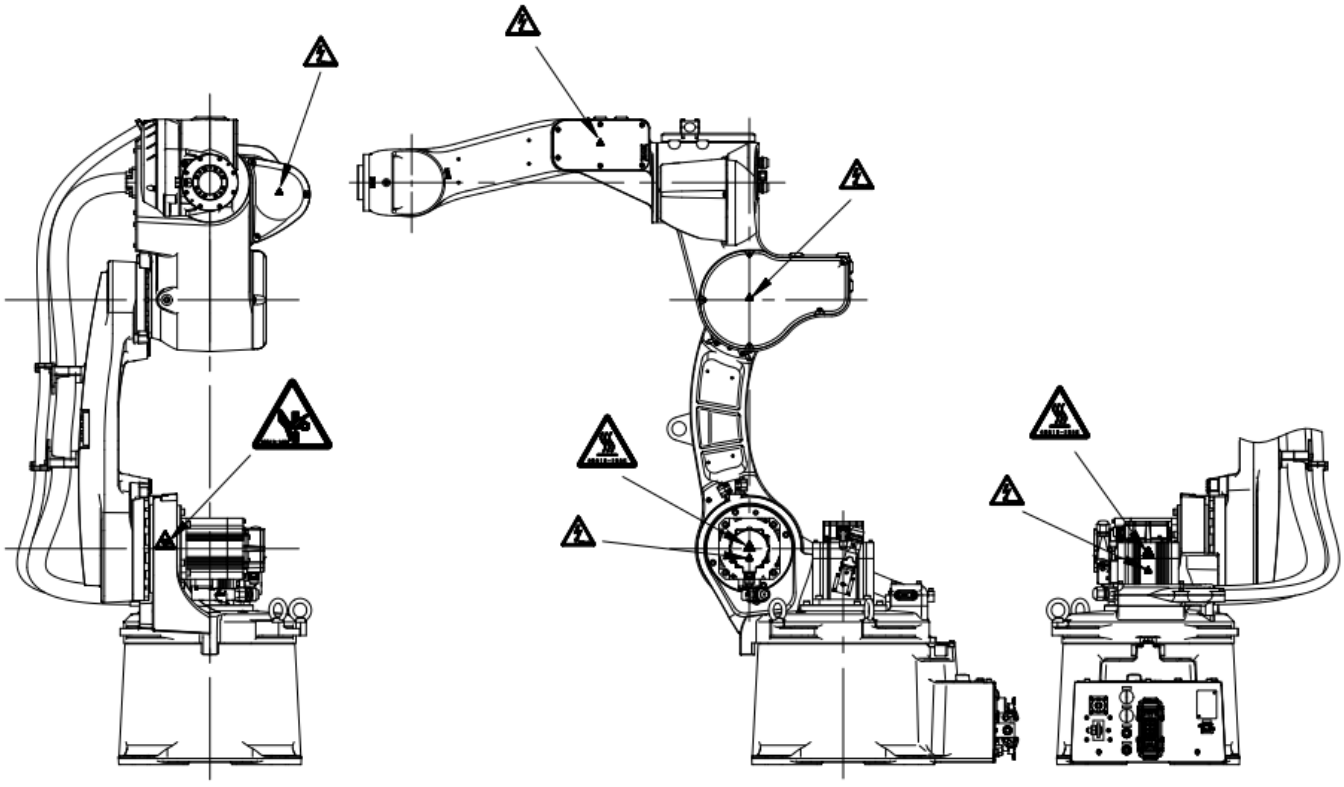
⚠ WARNING

Pay attention to the warning labels listed in the drawings below.

Warning label for high temperature

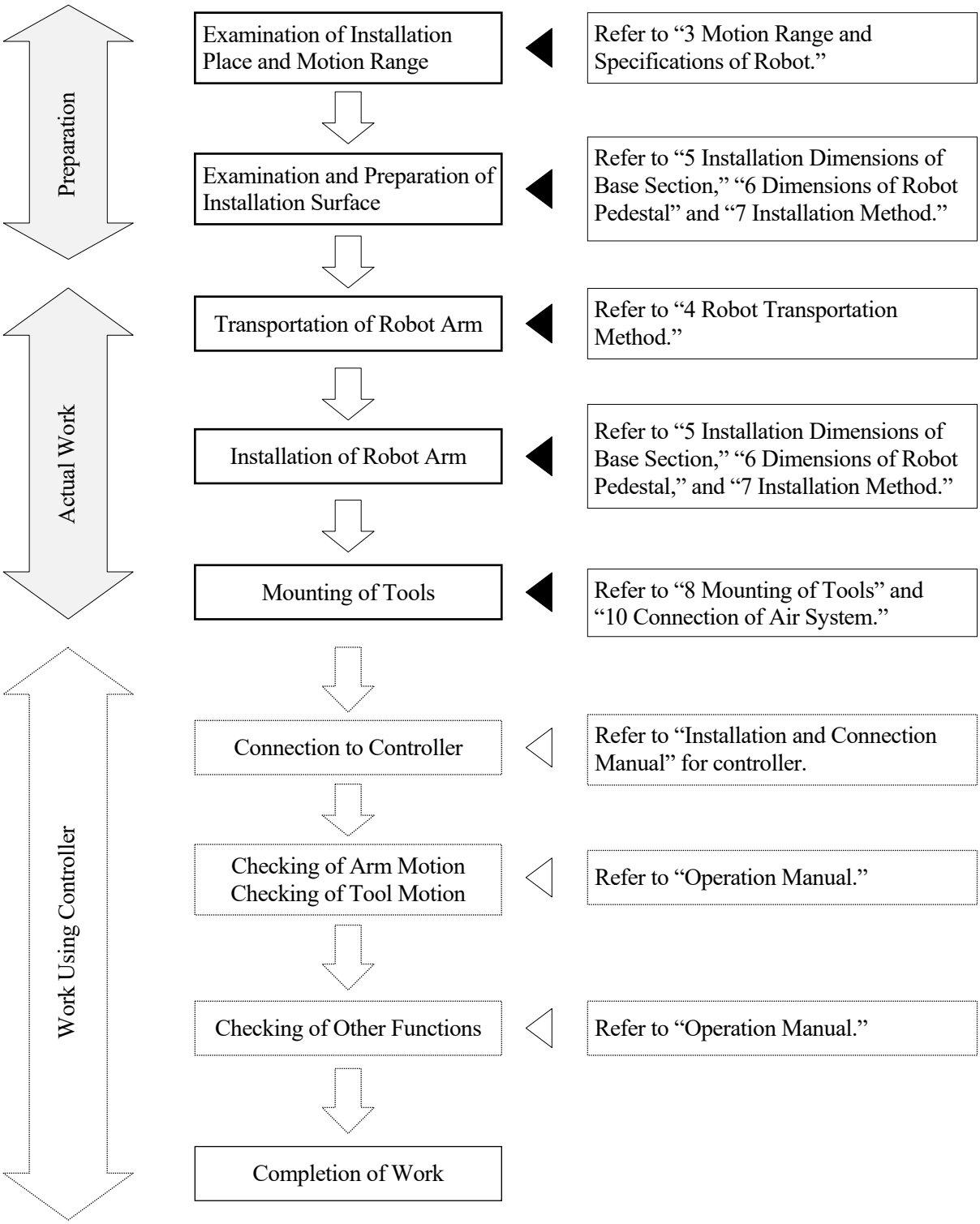
Warning label for pinching

Warning label for electric shock



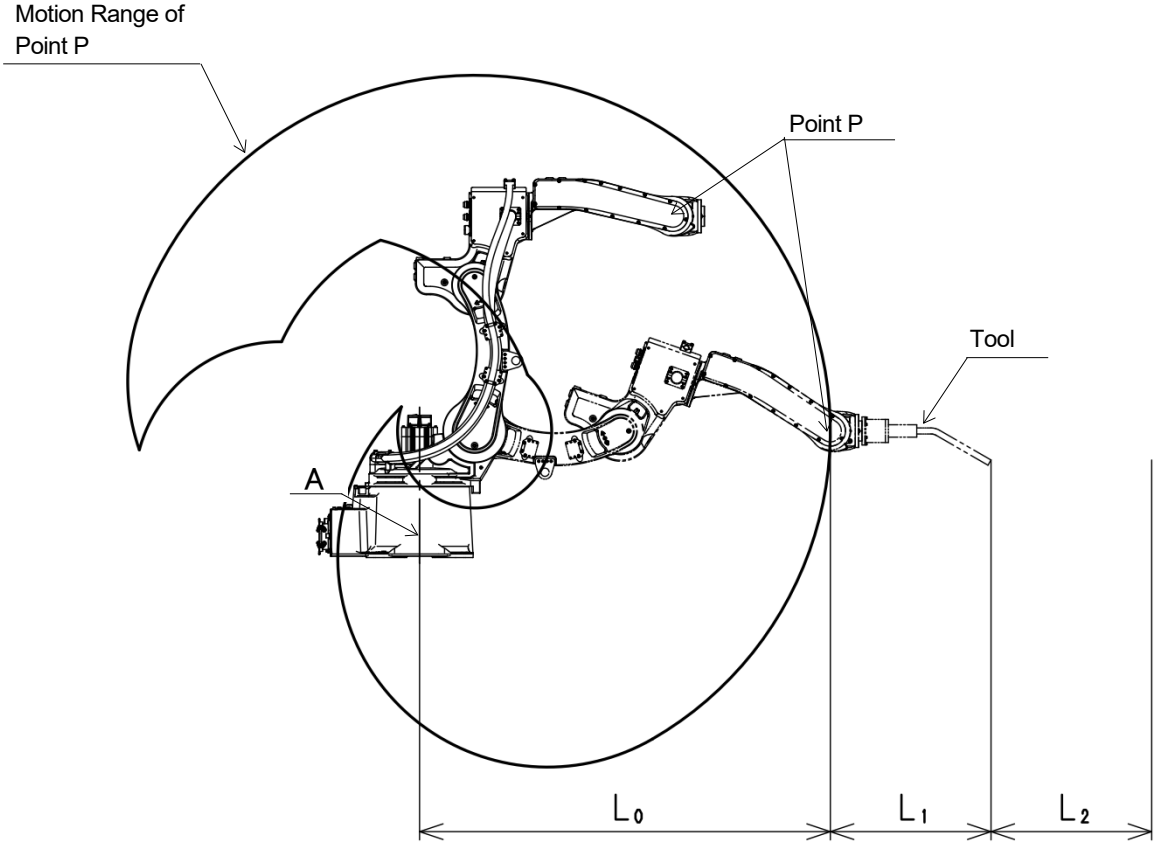
2 Work Flow at Arm Installation and Connection

This workflow describes only the robot arm section. For the controller, refer to "Installation and Connection Manual" for controller.

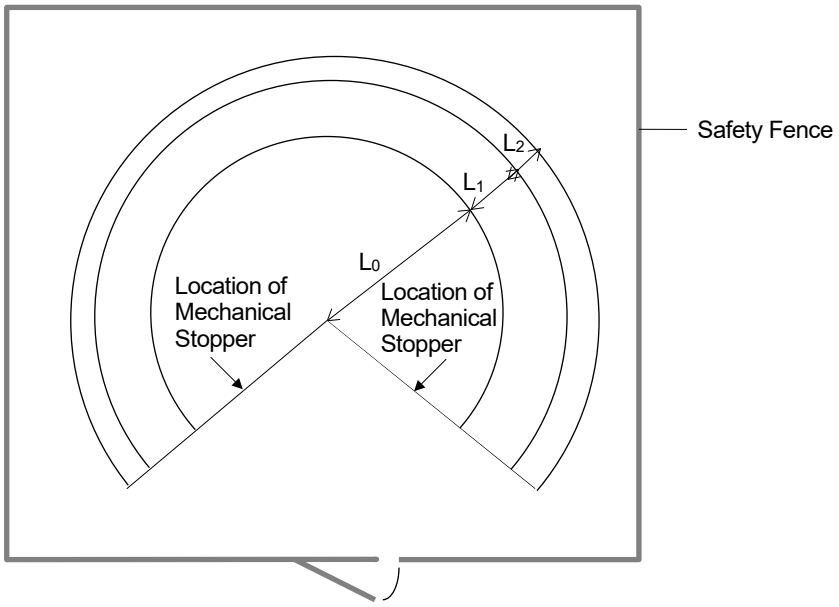


3 Motion Range and Specifications of Robot

3.1 Determination of Safety Fence Installation Location

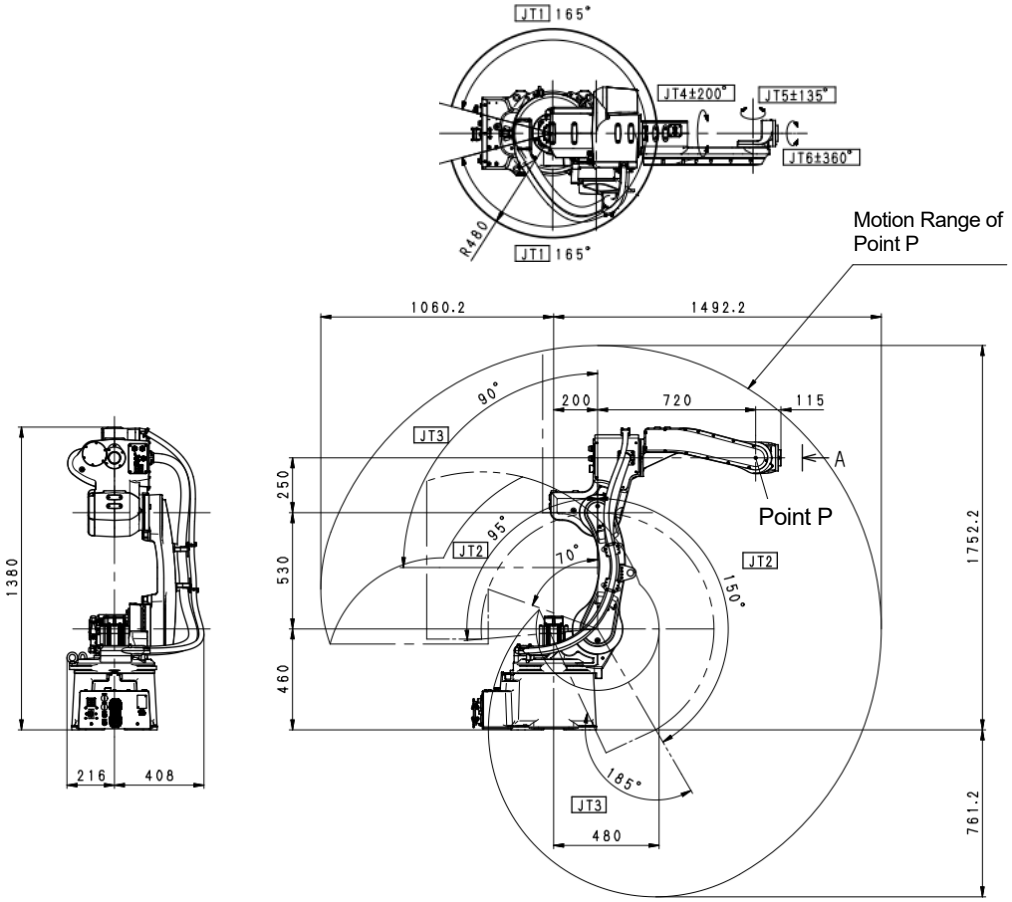


The motion range of the robot is represented by the maximum area that can be covered by point P in the figure above. Therefore, as shown in the figure below, install the safety fence outside circle whose radius is $L_0+L_1+L_2$. Where; L_0 is the length from the center line of arm (point A shown above) to the farthest point of P, L_1 is the length from point P to the farthest point of tool, and L_2 is safety margin. For the length of L_0, refer to the drawings in section 3.2.



3.2 Motion Range and Specifications of Robot

BA013N

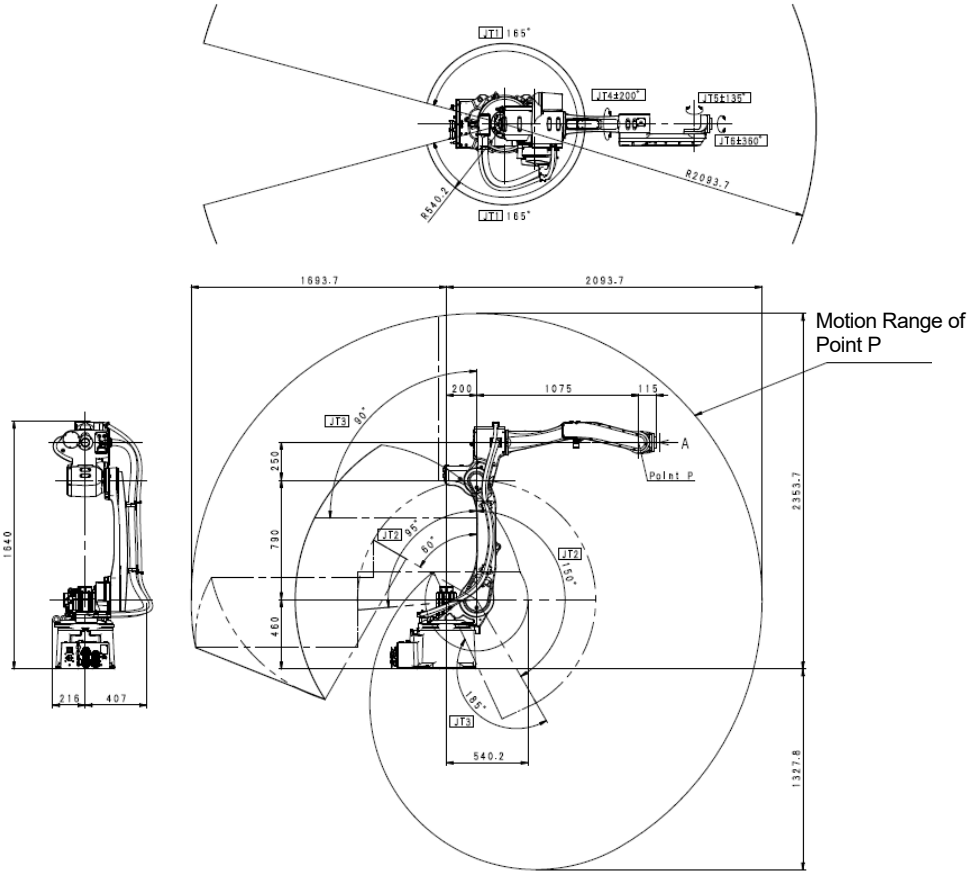


Type	Vertically articulated robot		
Degree of Freedom	6		
Motion Range and Maximum Speed	JT	Motion Range	Max. Speed
	1	±165°	265°/s
	2	+150° to -95°	250°/s
	3	+90° to -185°	265°/s
	4	±200°	470°/s
	5	±135°	475°/s
	6	±360°	730°/s
Max. Payload	13 kg		
Wrist Load Capacity	JT	Torque	Moment of Inertia
	4	26.0 N·m	0.90 kg·m^2
	5	26.0 N·m	0.90 kg·m^2
	6	10.0 N·m	0.30 kg·m^2
Repeatability	±0.04 mm		
Mass	260 kg		
Acoustic noise	< 80 dB (A)*		

*Measured condition
- installed on the plate rigidly fixed on the floor
- 2500 mm away from JT1 center
- General application motions

The noise level depends on the conditions.

BA013L



Type	Vertically articulated robot		
Degree of Freedom	6		
Motion Range and Maximum Speed	JT	Motion Range	Max. Speed
	1	±165°	215°/s
	2	+150° to -95°	215°/s
	3	+90° to -185°	270°/s
	4	±200°	440°/s
	5	±135°	475°/s
	6	±360°	730°/s
Max. Payload	13 kg		
Wrist Load Capacity	JT	Torque	Moment of Inertia
	4	26.0 N·m	0.90 kg·m^2
	5	26.0 N·m	0.90 kg·m^2
	6	10.0 N·m	0.30 kg·m^2
Repeatability	±0.06 mm		
Mass	280 kg		
Acoustic noise	< 80 dB (A)*		

*Measured condition
- installed on the plate rigidly fixed on the floor
- 3200 mm away from JT1 center
- General application motions

(The noise level depends on the conditions.)

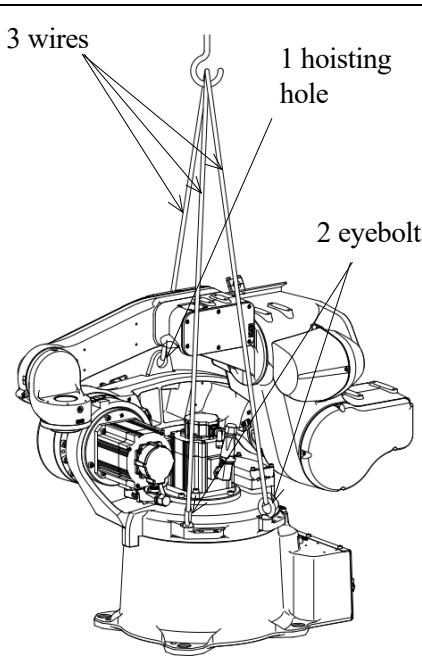
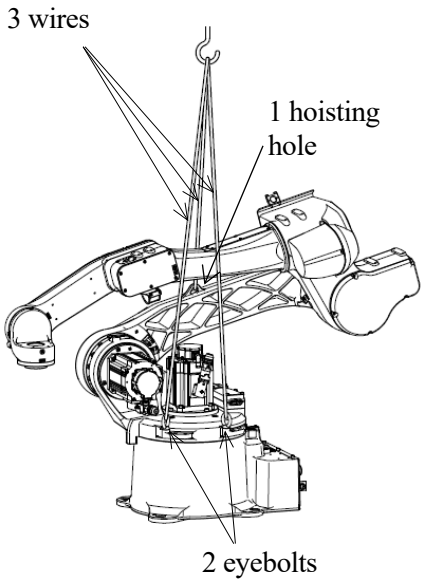
4 Robot Transportation Method

4.1 Using Wire Sling (without Base Plate)

As shown in the figure below, fasten wire slings to two eyebolts and a hoisting hole on the arm and hoist up the robot. (Use the same method for hoisting up the robot with pedestal.)

⚠ CAUTION

When hoisting up the robot, be careful as robot may lean forward/backward depending on robot posture and installation condition of the options. If the robot is hoisted up in an inclined posture, it may swing, damage or the wire may interfere with the harness, piping etc., or it may damage due to interfering with surrounding objects. Protect the robot with guard plates, etc. if wires interfere with a part of the robot.

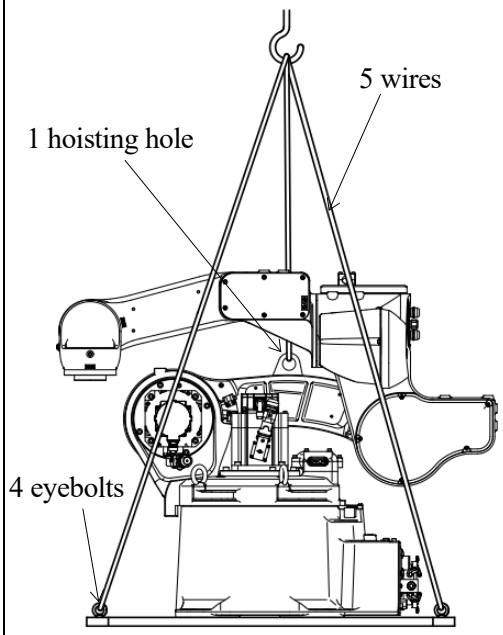
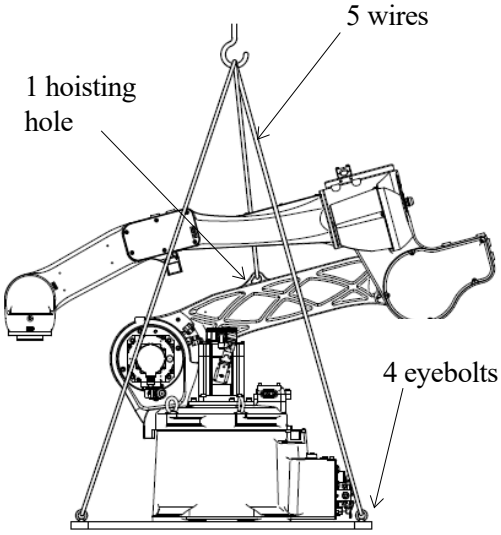
Model		BA013N	BA013L
Hoisted up posture			
Hoisted up posture	JT1	0°	0°
	JT2	-95°	-75°
	JT3	-185°	-180°
	JT4	0°	0°
	JT5	-90°	-75°
	JT6	0°	0°
Hoisting parts on arm		Eyebolt: M12 × 2 pcs	

4.2 Using Wire Sling (with Base Plate)

According to the figure below, hoist up the robot by fastening four wire slings to four eyebolts on the base plate. In addition, fasten a wire sling to a hoisting hole on the arm to prevent the robot from accidentally falling. (Use the same method for hoisting up the robot with pedestal.)

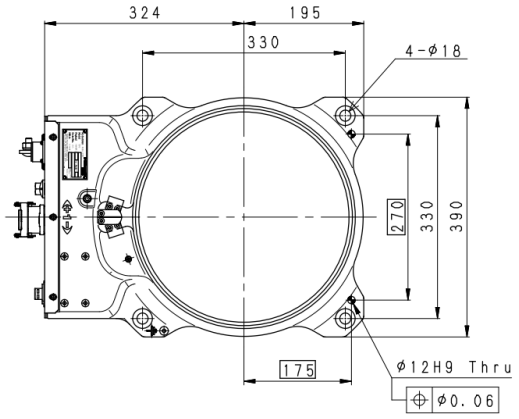
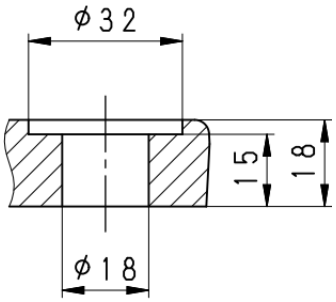
⚠ CAUTION

When hoisting up the robot, be careful as robot may lean forward/backward depending on robot posture and installation condition of the options. If the robot is hoisted up in an inclined posture, it may swing, damage or the wire may interfere with the harness, piping etc., or it may damage due to interfering with surrounding objects. Protect the robot with guard plates, etc. if wires interfere with a part of the robot.

Model		BA013N	BA013L
Hoisted up posture			
Hoisted up posture	JT1	0°	0°
	JT2	-95°	-75°
	JT3	-185°	-180°
	JT4	0°	0°
	JT5	-90°	-75°
	JT6	0°	0°

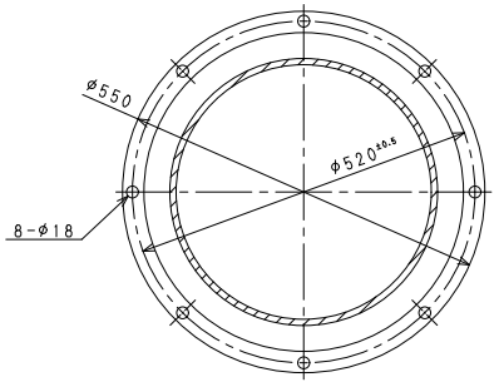
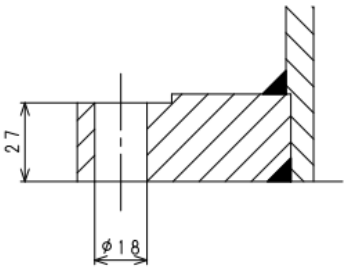
5 Installation Dimensions of Base Section

When installing a robot, fix the base section with high tension bolts through the bolt holes.

Model	BA013N, BA013L
Dimensions for installation	
Cross-section of installation section	
Bolt hole	4-⌀18
High tension bolt	4-M16 Material: SCM435 Strength class: 10.9 or more.
Tightening torque	240 N·m
Levelness	Within ±5°

6 Dimensions of Robot Pedestal

When installing a robot on the pedestal, fix the pedestal with high tension bolts through the bolt holes.

Model	BA013N, BA013L
Dimensions for installation	
Cross-section of installation section	
Bolt hole	8-ø18
High tension bolt	8-M16 Material: SCM435 Strength class: 10.9 or more
Tightening torque	240 N·m
Levelness	Within ±5°

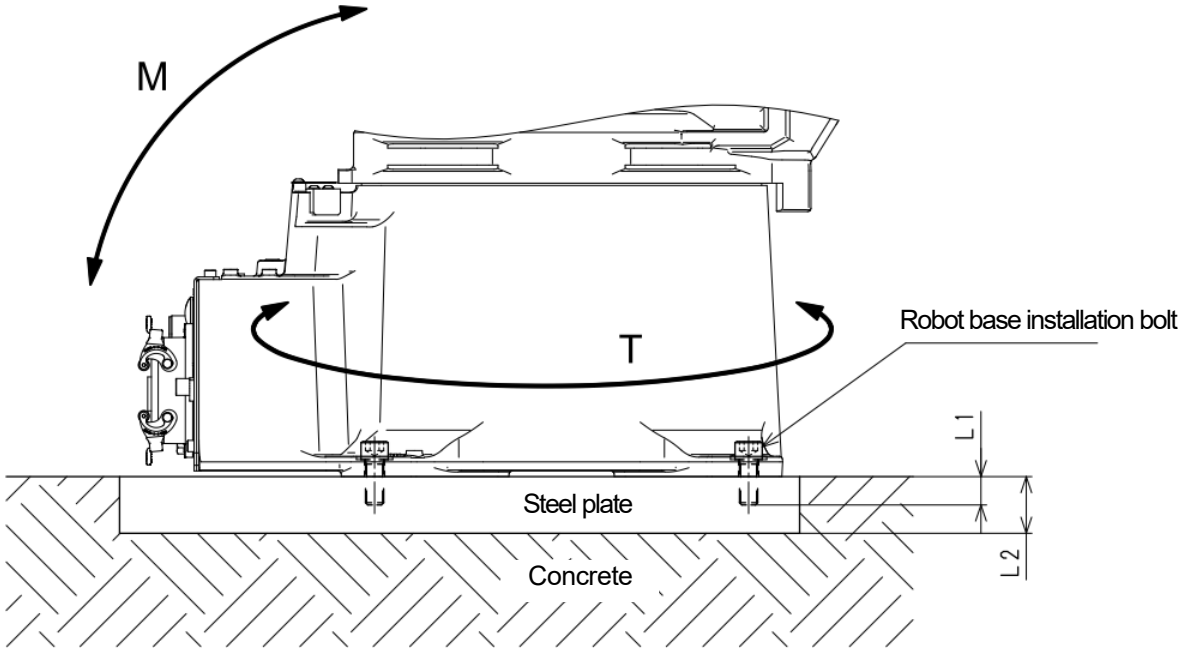
7 Installation Method

WARNING

When installing the robot on the ceiling, the robot may fall or be damaged during the installation operation. Be sure to contact nearest Kawasaki when using this installation method.

7.1 When Installing the Robot Directly on the Floor

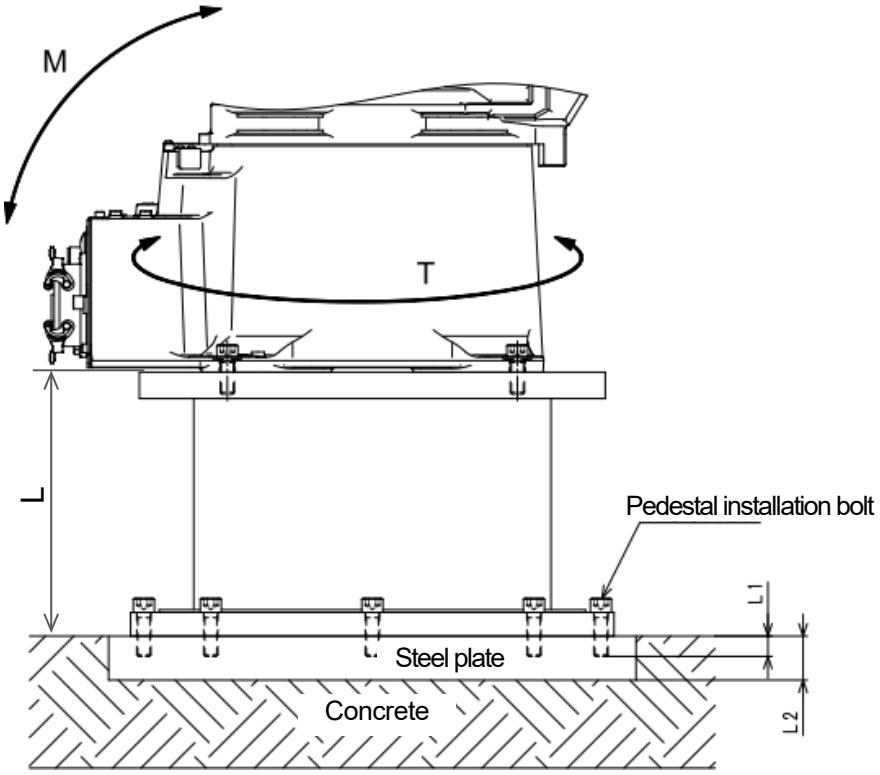
In this case, bury steel plate of L2 thickness (See the table below.) in the concrete floor as shown in the figure below or fix it with anchors. Fix the steel plate firmly enough to endure the reaction forces produced by the robot.



Model	BA013N	BA013L
M (Inversion moment)	5805 N·m	8387 N·m
T (Rotating torque)	4541 N·m	6416 N·m
Robot base installation bolt	4-M16	
Tightening torque	240 N·m	
L1	25 mm or more	
L2	28 mm or more	

7.2 When Installing the Robot Pedestal on the Floor

In this case, the installation procedures are practically the same as the procedure shown in the section 7.1.

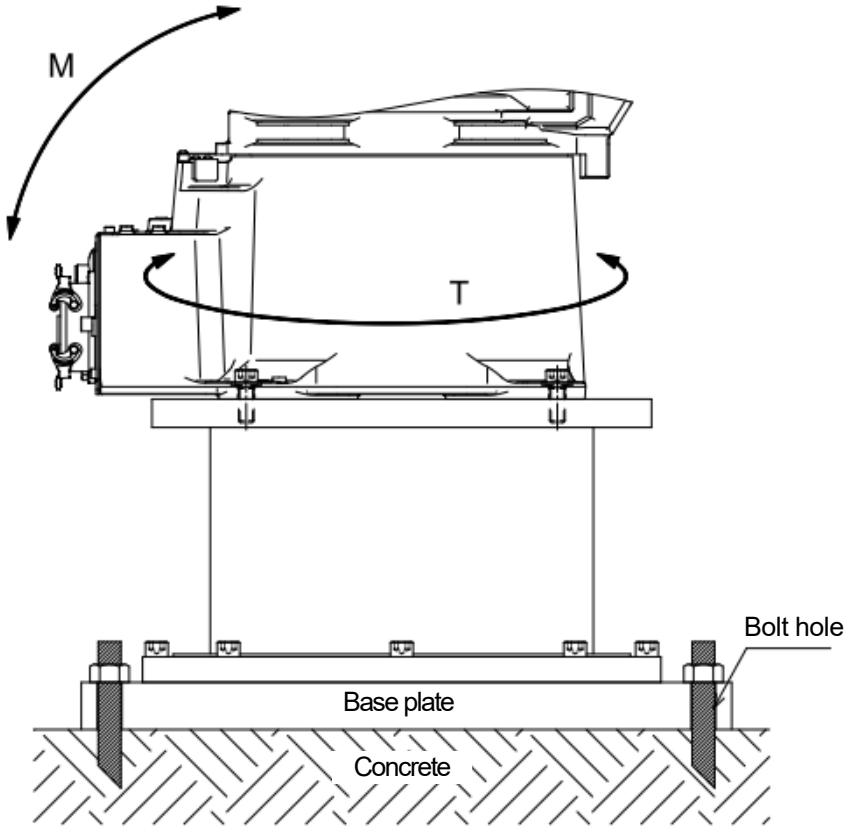


Model	BA013N	BA013L
M (Inversion moment)	5805 N·m	8387 N·m
T (Rotating torque)	4541 N·m	6416 N·m
Pedestal mass	115 kg (L=600)	
	87 kg (L=300)	
Pedestal installation bolt	8-M16	
Tightening torque	240 N·m	
L	600 (60360-2945*)	
	300 (60360-2944*)	
L1	21 mm or more	
L2	25 mm or more	

NOTE* ( ) indicates the part number of pedestal.

7.3 When Installing the Robot Base Plate on the Floor

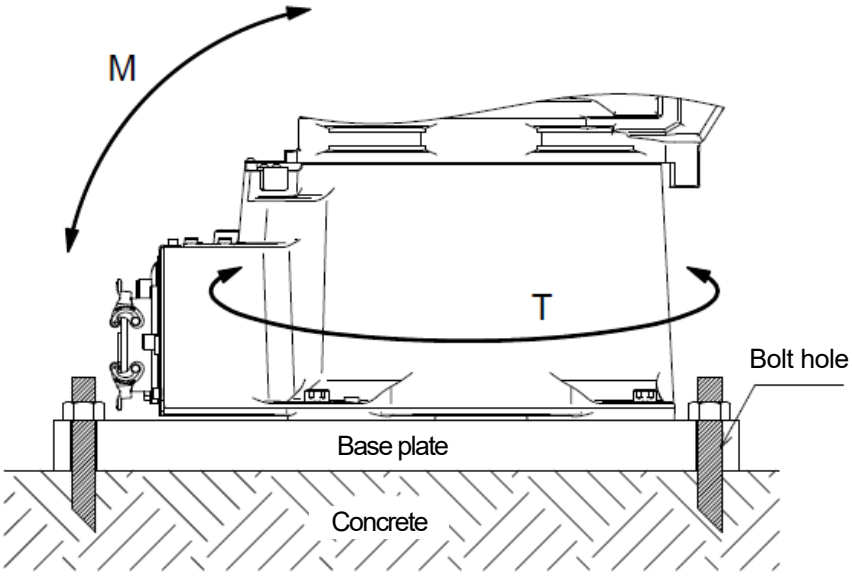
In this case, install the base plate on concrete floor or steel plate using bolt holes on the base plate.



Model	BA013N	BA013L
M (Inversion moment)	5805 N·m	8387 N·m
T (Rotating torque)	4541 N·m	6416 N·m
Part number of pedestal installation base plate	60360-0085	
Base plate mass	110 kg	
Base plate installation hole	4-ø26 (PCD800)	
Base plate dimension (mm)	750 × 750 × 25	

7.4 Installing the Robot Base Plate on the Floor (without Pedestal)

In this case, install the base plate on concrete floor or steel plate using bolt holes on the base plate.



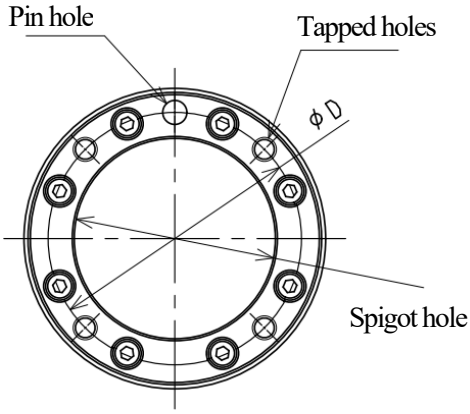
Model	BA013N	BA013L
M (Inversion moment)	5805 N·m	8387 N·m
T (Rotating torque)	4541 N·m	6416 N·m
Part number of base plate	60360-3007	
Base plate mass	110 kg	
Base plate installation hole	4-⌀26 (PCD800)	
Base plate dimension (mm)	750 × 750 × 28	

8 Mounting of Tools

WARNING

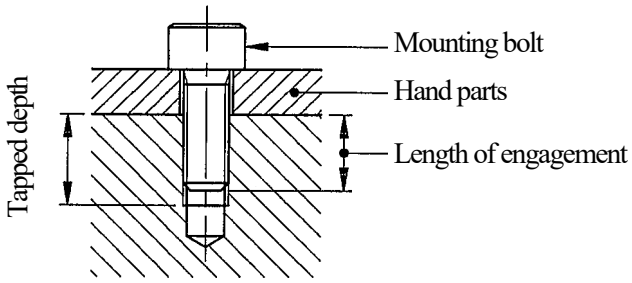
Prior to mounting tools on the robot, turn OFF the controller power switch and the external power switch. Display signs indicating clearly "Installation and connection in progress," and lock out/tag out the external power switch to prevent personnel from accidentally turning ON the power.

8.1 Dimensions of Wrist End



In the robot arm end section, a flange is provided on which a tool is mounted. Screw the mounting bolts into the tapped holes on the circumference of ⌀D on the flange, referring to the figure on the left. Moreover, position the tool by utilizing the pin hole and the spigot hole.

8.2 Specification of Mounting Bolt



Select mounting bolts with proper length to secure the specified engagement length. Use high tension mounting bolt and tighten them to the specified torque.

CAUTION

If the engagement length has exceeded the specified value, the mounting bolt might bottom out, and the tool will not be fixed securely.

Model	BA013N, BA013L
Tapped holes	4-M6
⌀D	⌀3
Pin hole	⌀6H7 Depth 6
Spigot hole	⌀50H7 Depth 5
Tapped depth	12 mm
Length of engagement	9 to 10 mm
High tension bolt	SCM435, 10.9 or more
Tightening torque	12 N·m

8.3 Load Capacity

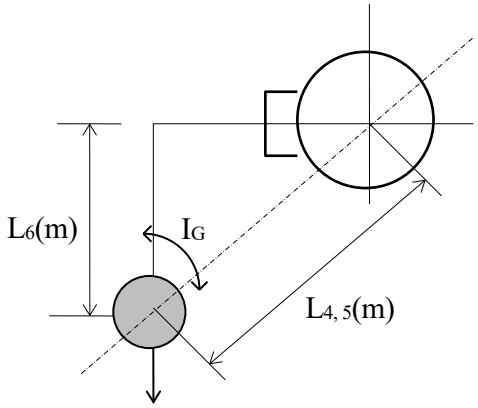
Load mass applicable to robot is specified for each model and includes the mass of a hand and gun, etc. Applicable load torque and moment of inertia around wrist axes (JT4, JT5, JT6) are also specified. Strictly observe the following restrictions on them.

⚠ CAUTION

Using the robot beyond its specified load may result in degradation of movement performance and shortening of machine service life. The load mass includes the tool mass such as hand, tool changer, shock absorber, etc. If using the robot in excess of its load capacity, first contact Kawasaki without fail.

The load torque and the moment of inertia can be calculated by the expression below:

Calculation Expression



Load mass (including hand) : $M \leq Mmax.$ (kg)

Load torque : $T=9.8 \cdot M \cdot L$ (N·m)

Load moment of inertia: $I=M \cdot L^2+I_G$ (kg·m^2)

Mmax: Maximum load mass: See Section 3.2.

L: Length from axis rotation center to load center of gravity. (Unit: m) (See the figure)

$L_{4,5}$: Length from JT4(5) axis rotation center to load center of gravity.

L_6: Length from JT6 axis rotation center to load center of gravity.

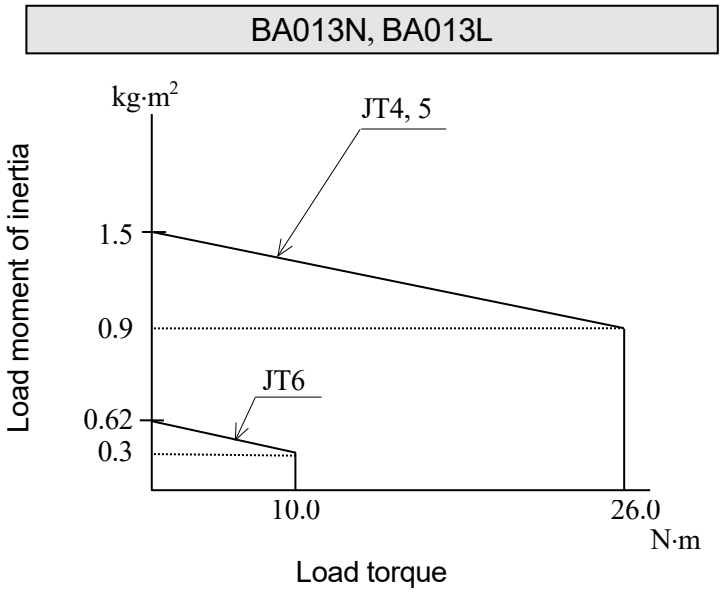
I_G: Moment of inertia around center of gravity. (Unit: kg·m^2)

If calculation of load is made by dividing the load into construction parts, such as hand and workpieces, use the total calculation values of each part as load torque and moment of inertia.

Regarding the load on the robot wrist section, meet the following restriction conditions:

1. The load mass including hand mass should be less than the following value.
   BA013 = 13 kg
2. The load torque and the moment of inertia around each wrist axis (JT4, JT5, JT6) should be within the following restriction*:

NOTE* Load moment of inertia exceeding the restriction may be acceptable. In this case, ensure to specify the load. (However, the robot movement may become slow or shake easily because of adjusting acceleration and deceleration.) See "AS Language Reference Manual" for setting the load. Operating the robot with wrong settings may result in degradation of movement performance and shortening of machine service life.



9 Mounting External Equipment

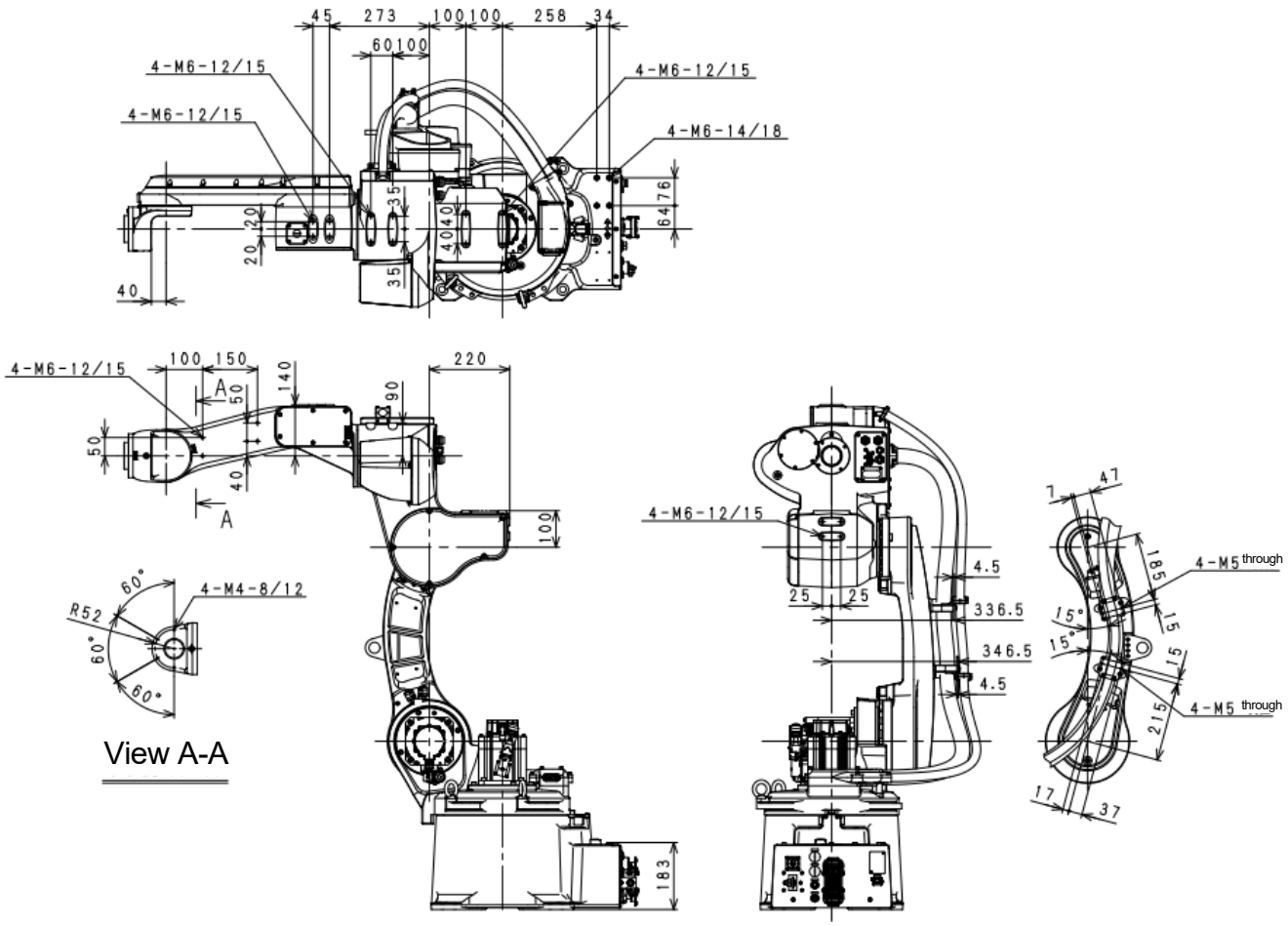
9.1 Service Tapped Hole Positions

Service tapped holes shown in the figure below are available to mount wiring brackets and external equipment on each part of robot arm.

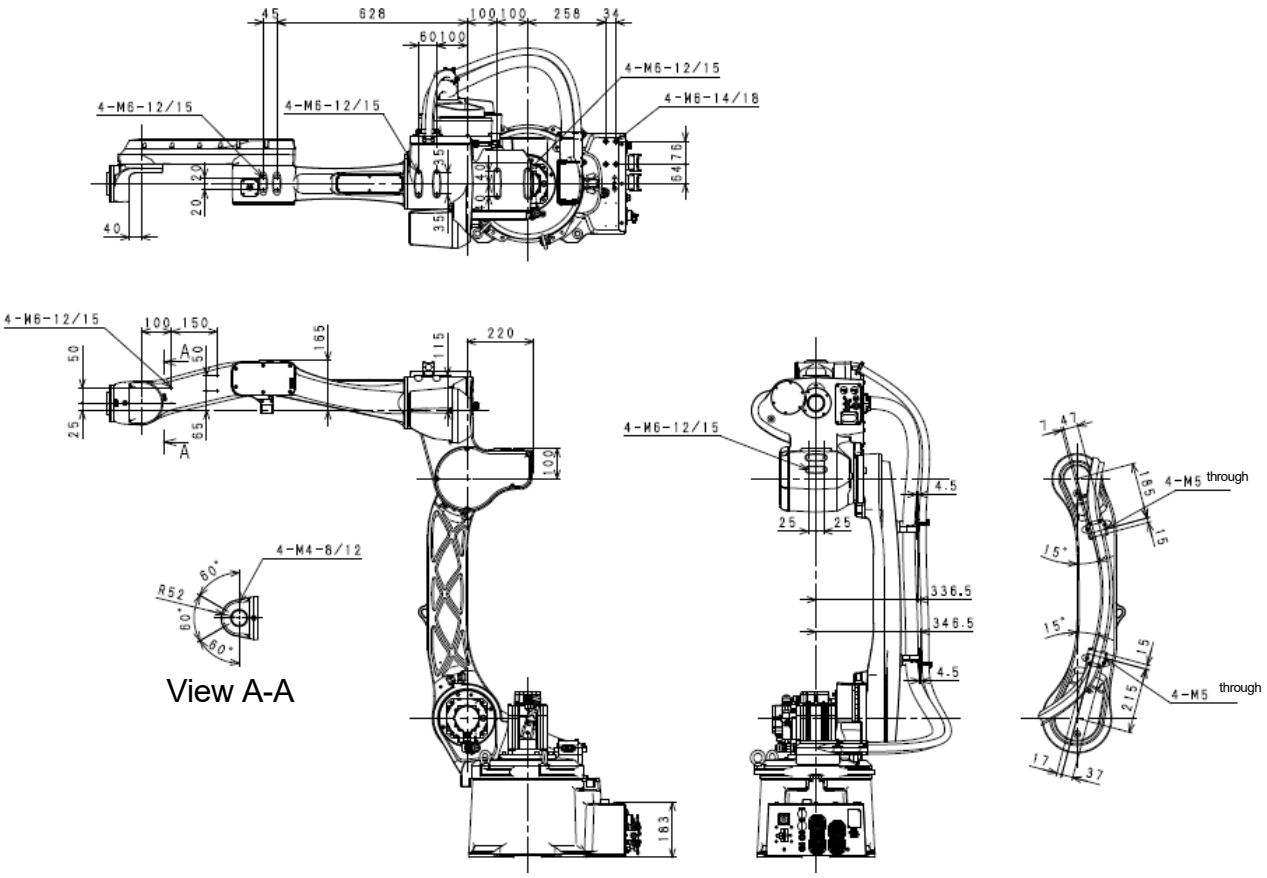
CAUTION

Check the robot movement very carefully and confirm that mounted brackets and external equipment do not interfere with peripheral equipment and robot arm itself.

BA013N



BA013L


4-M6-12/15
4-M6-12/15
4-M6-12/15
4-M6-14/18
4-M4-6/12
View A-A
4-M6-12/15
4-M5 through
4-M5 through

9.2 Calculation of Load Caused by External Equipment

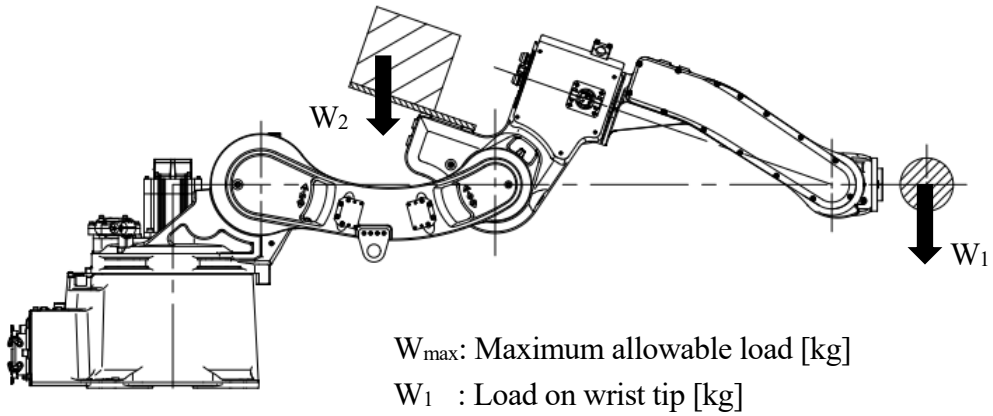
The mass load capacity of the robot is fixed for each model. Strictly observe the restrictions as follows.

⚠ CAUTION

If a load at or above the rated value is applied, this can result in deteriorated operational functionality or service life. If an amount other than the rated load will be applied, consult with Kawasaki.

Limit the total load on wrist tip and JT3 rear part of the upper arm not to exceed the maximum allowable load. The load mass values can be calculated by the expression in the figure below.

Calculation Expression



W_{max}: Maximum allowable load [kg]
W_1 : Load on wrist tip [kg]
W_2 : Total load on JT3 rear part of upper arm [kg]

・ $W_1 + W_2 \leq W_{max}$

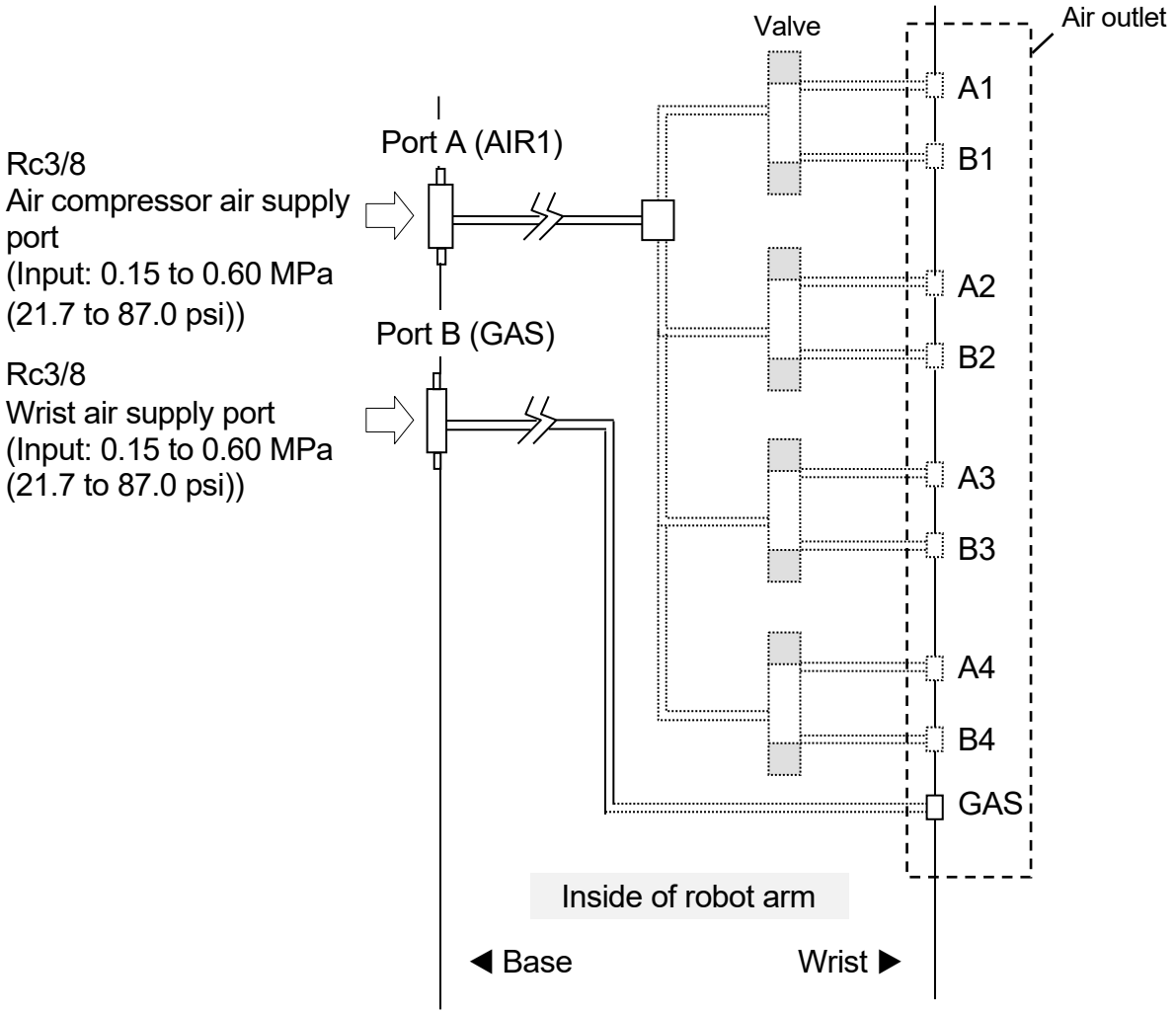
For W_1 and W_{max}, do not exceed the values shown in the table below.

	W_1 [kg]	W_{max} [kg]
BA013N, BA013L	13	23

10 Connection of Air System

10.1 Air Piping

The air piping and valves for driving the tool are housed in the robot arm. The valves can be turned ON/OFF by the Teach Pendant without using an interlock panel.



Note Optional equipment is shown by the dotted line (.....).

The built-in valves are specified as follows:

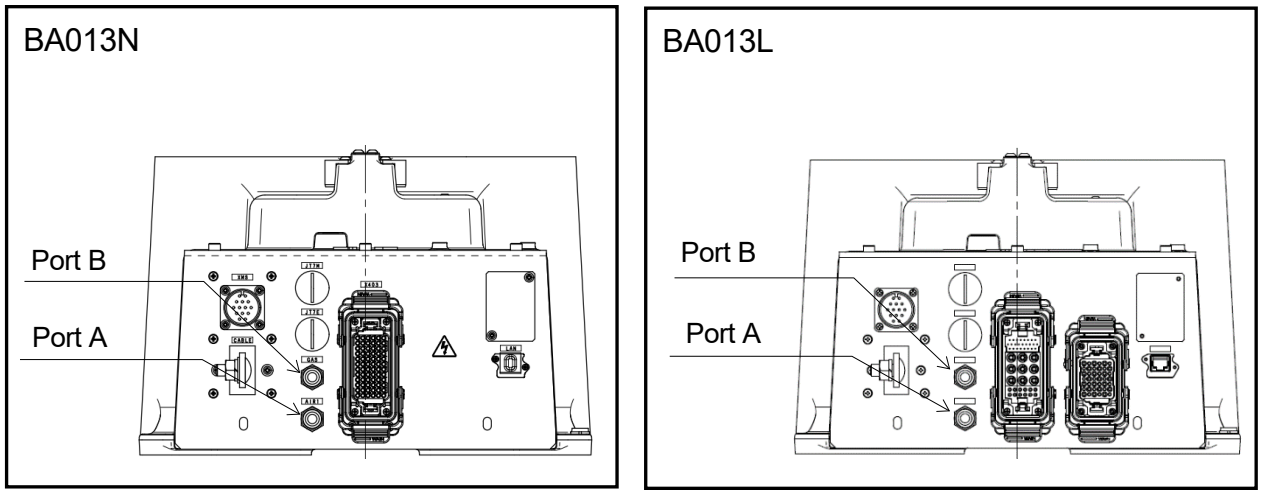
Standard	No built-in valve
Option	Double solenoid/Single solenoid valves 4 units max.

Note For the valve specification of BA013, CV value is 0.2 and the number of switching positions is 2.

[NOTE]

Valves that do not meet the specifications on the previous page cannot be mounted in the arm. Please contact Kawasaki for information on air system specifications if such valves are used.

10.2 Air Supply to the Robot Arm



As shown above, the air connection ports are provided in the base section of robot arm.

CAUTION

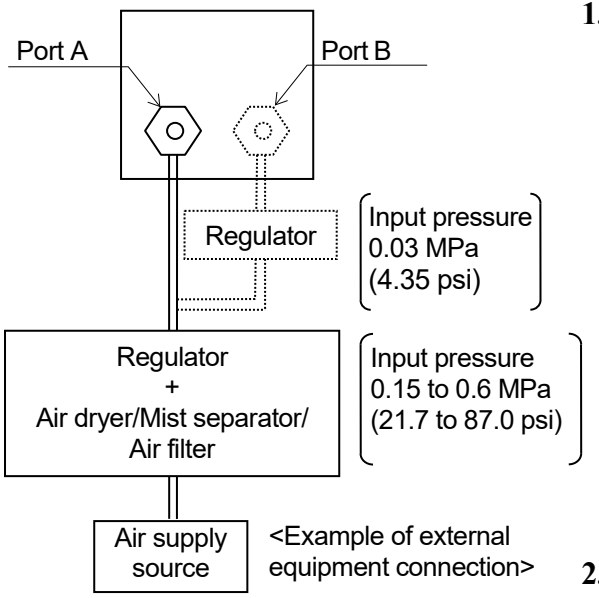
Supply clean dry air with input pressure of 0.15 to 0.6 MPa (21.7 to 87.0 psi) to the Port A (Rc3/8).

Tighten the couplers connected to the ports with 6.9 N·m or below.

CAUTION

When connecting the couplers, the frame may be damaged if the couplers are tightened with a large torque.

⚠ CAUTION

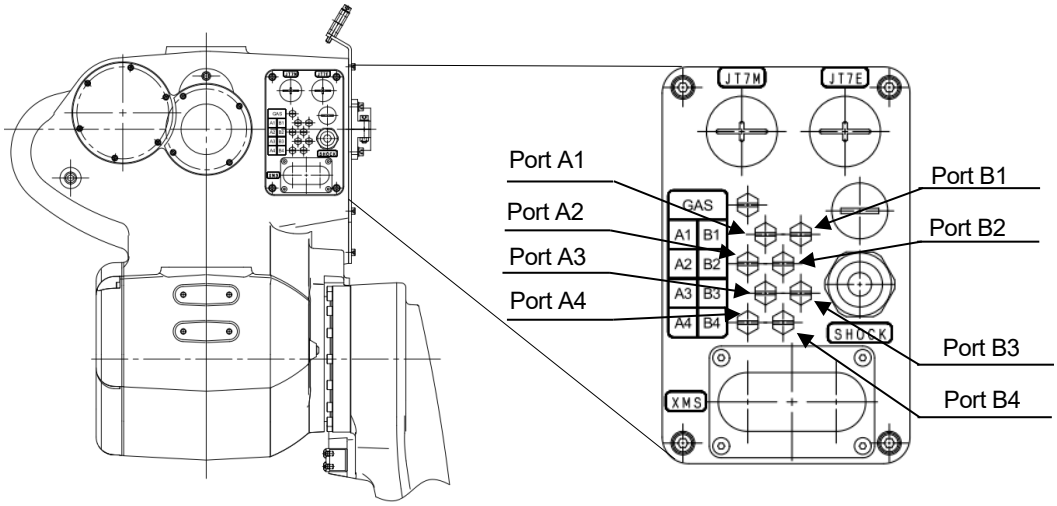


1. **Connect external equipment such as an air dryer, a mist separator and an air filter when the supplied air includes water, oil, dust, etc., because the air supply may lead to malfunction or damage on the built-in valves or the devices inside the arm. In addition, conduct maintenance of the connected equipment (draining, filter cleaning, etc.) periodically.**

2. **Since built-in valves are non-oiling type, do not use any lubricator (oiler).**

10.3 Tubing from Air Outlet to Hand

As shown in the figure below, air outlet ports are provided. The outlet ports are M5.



CAUTION

When tubing, ensure that the air outlet ports are not turned.
If the outlet ports turn, the internal tube may bend or break causing air supply stop at worst.

Appendix 1 Stopping Performance of Robot

This robot is controlled by the stopping method prescribed in the standard IEC60204-1. In this chapter, the stopping distance or angle and the stopping time by categories are shown.
The stopping distance or angle and the stopping time are based on Annex B of ISO 10218-1 standard.

Stopping distance (angle):	The distance or angle until the robot comes to a complete stop after the stop command is given
Stopping time:	The time until the robot comes to a complete stop after the stop command is given

Calculate the stopping distance from the stopping angle of each axis considering stopping category, load, speed, extension and workpiece size shown in this section, and perform appropriate risk assessments. The values shown in this chapter may be different from the actual stopping distance or angle and the stopping time depending on the influence inside and outside the robot and the motion and posture at stop, so check the values before use.

1. Definition of terms
   Load: Loading mass on flange section
   Speed: Speed of robot
   Extension: Distance from JT1 center of rotation to TCP (tool center point)

2. JT1/JT2/JT3 stopping angle and stopping time in category 0
   [Measurement conditions]
   Load: Maximum load
   Speed: Maximum speed
   Extension: Maximum extension

BA013N

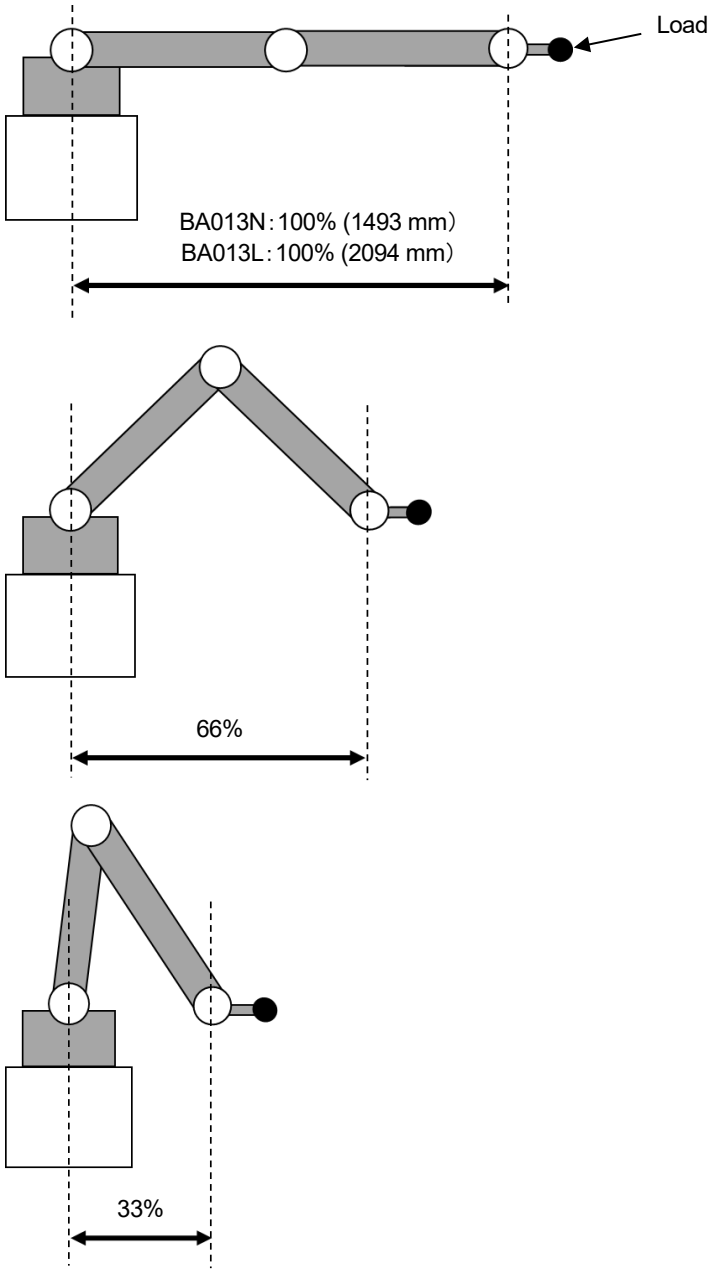
Axis	Stopping angle [deg]	Stopping time [sec]
JT1	33.9	0.6
JT2	29.1	0.5
JT3	23.2	0.5

BA013L

Axis	Stopping angle [deg]	Stopping time [sec]
JT1	3.1	0.4
JT2	21.7	0.7
JT3	17.7	0.8

3. JT1/JT2/JT3 stopping angle and stopping time in category 1
   The stopping angle and the stopping time are values for each combination when load, speed, and extension are at 33%, 66%, and 100%, respectively.

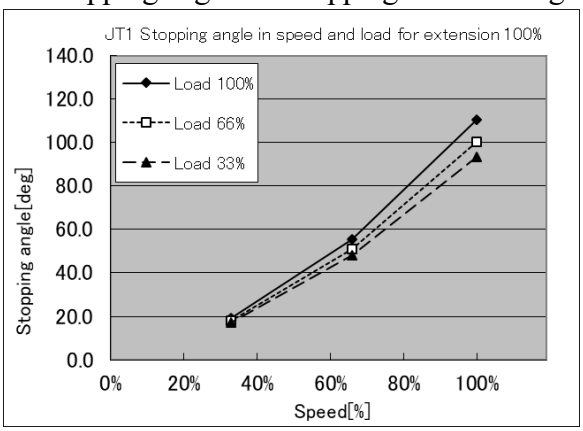
   • Extension diagram

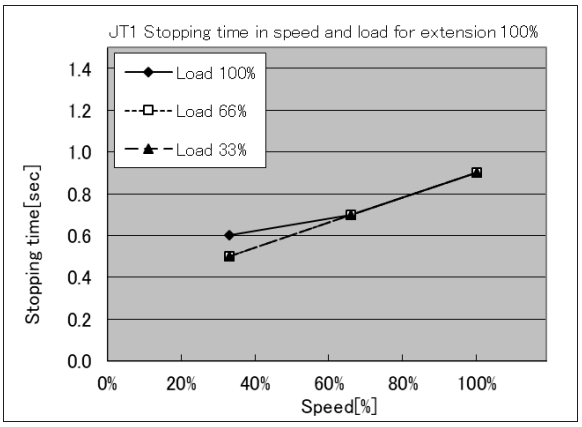


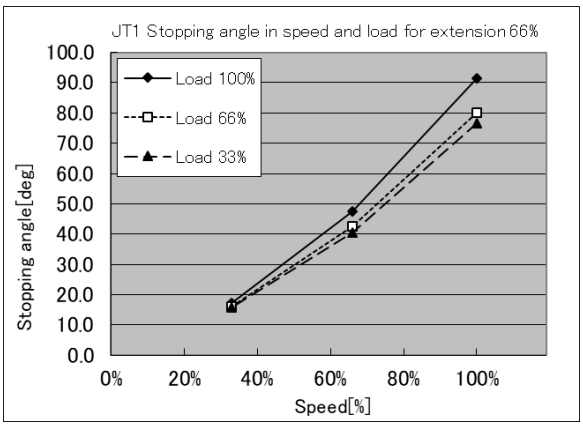
■ Stopping angle and stopping time

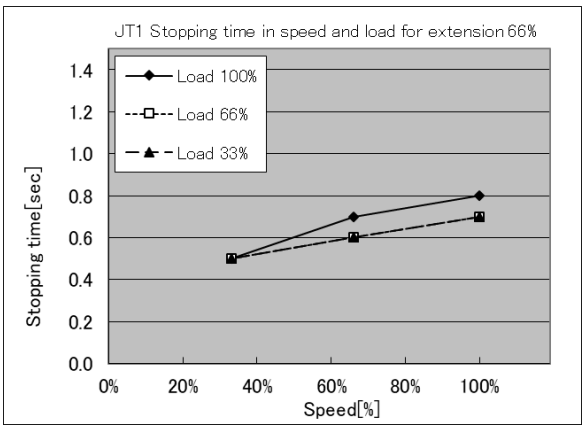
BA013N

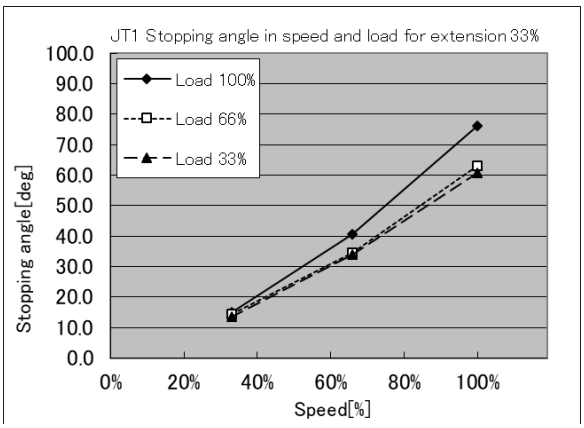
- Stopping angle and stopping time in category 1: JT1

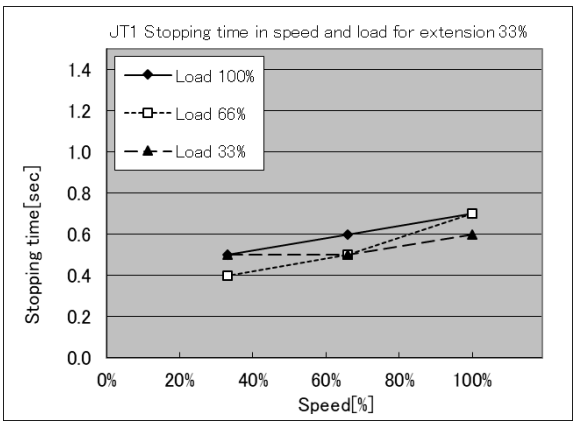




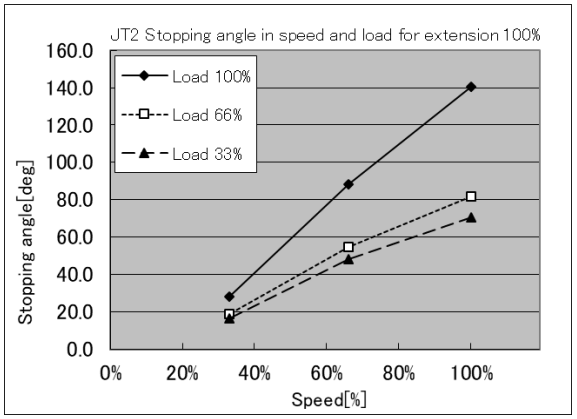


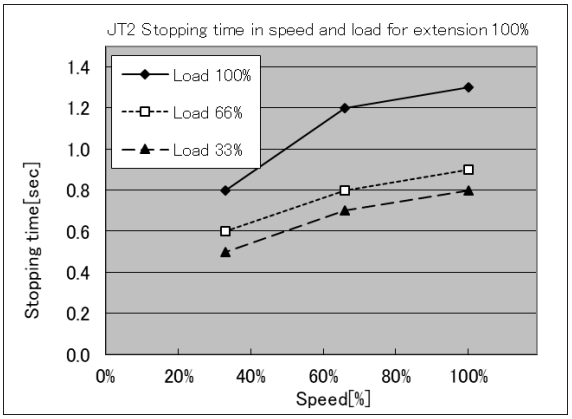


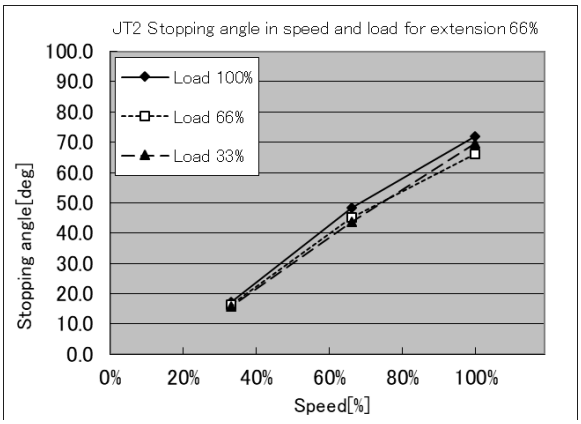


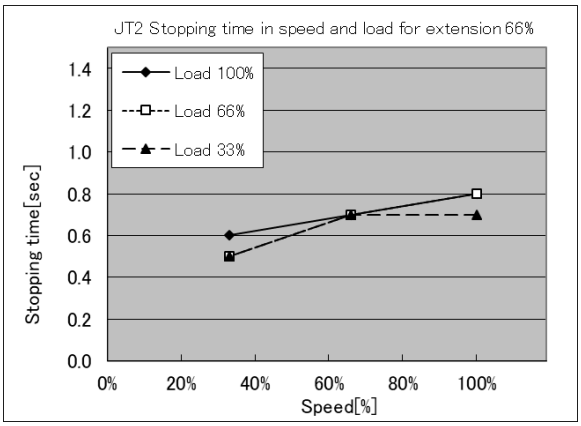


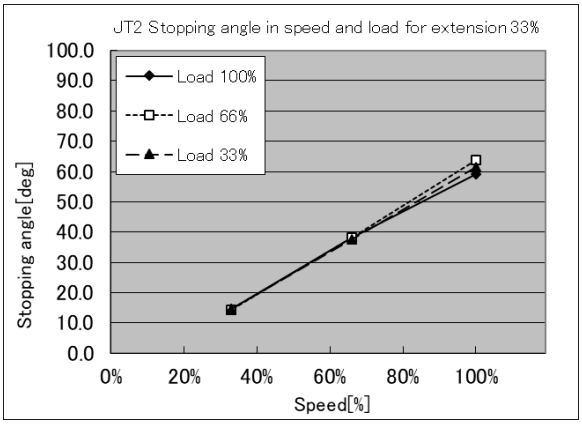
- Stopping angle and stopping time in category 1: JT2

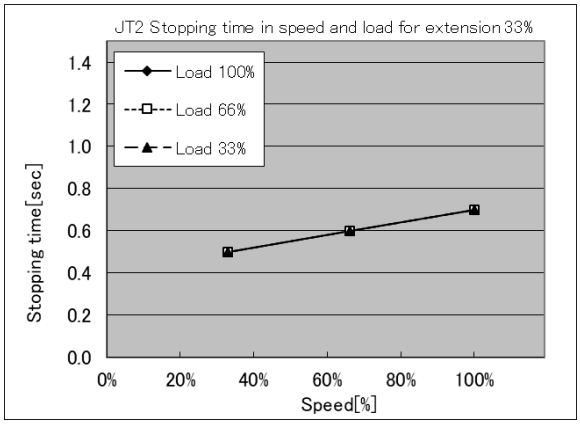




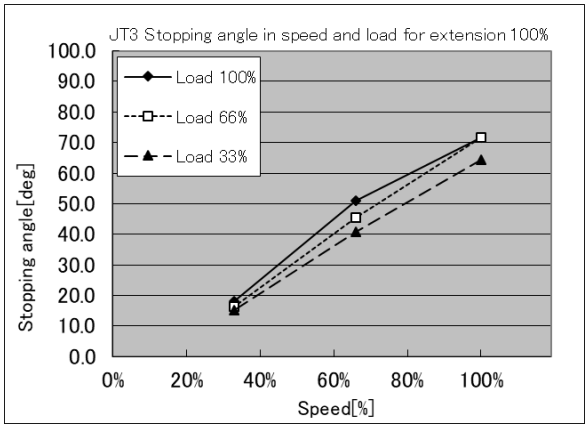


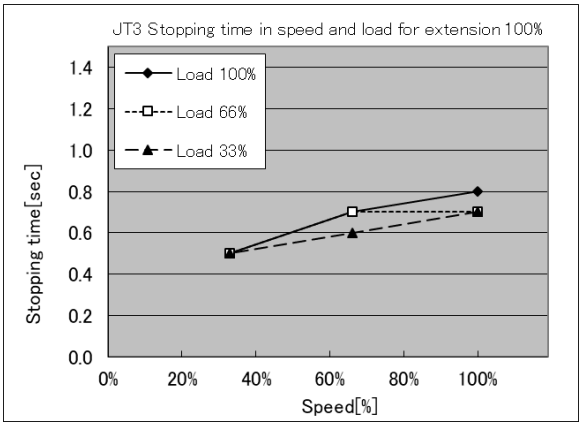






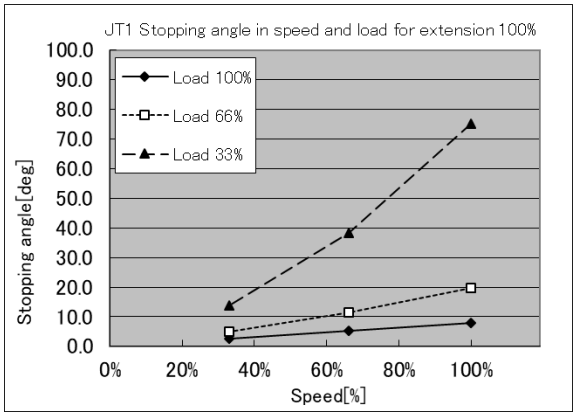
- Stopping angle and stopping time in category 1: JT3 (posture 100% only)

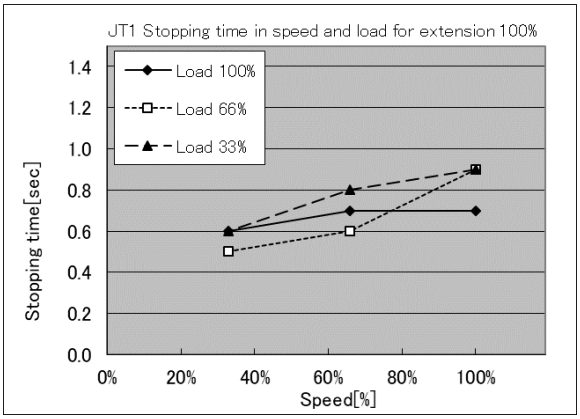


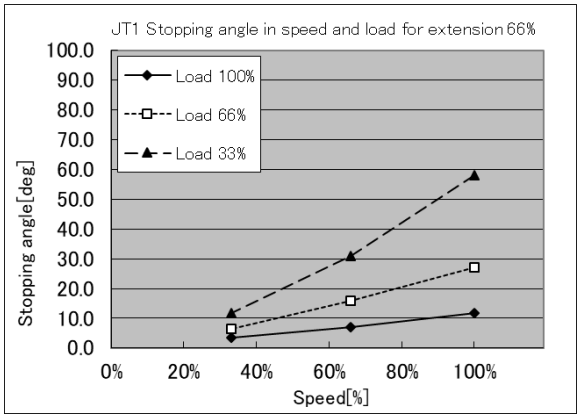


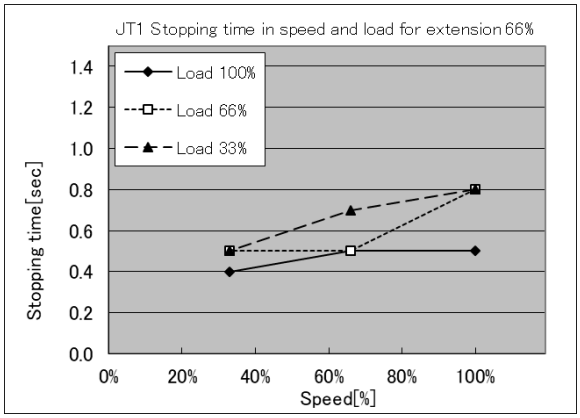
BA013L

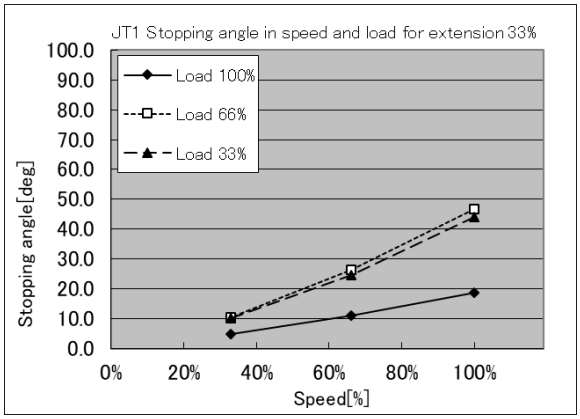
- Stopping angle and stopping time in category 1: JT1

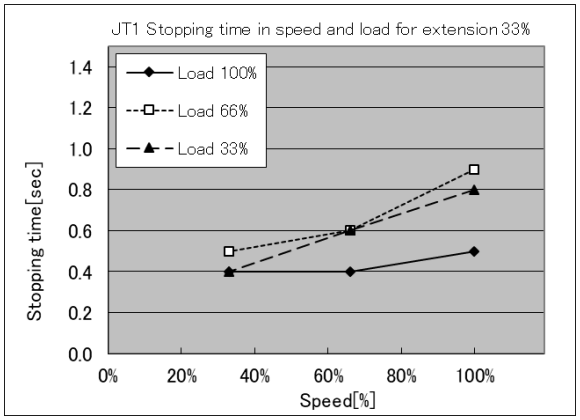




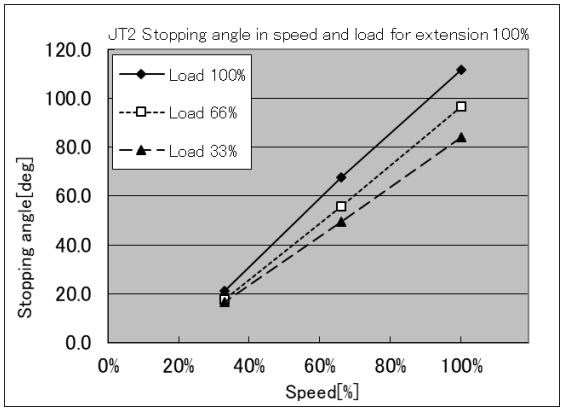


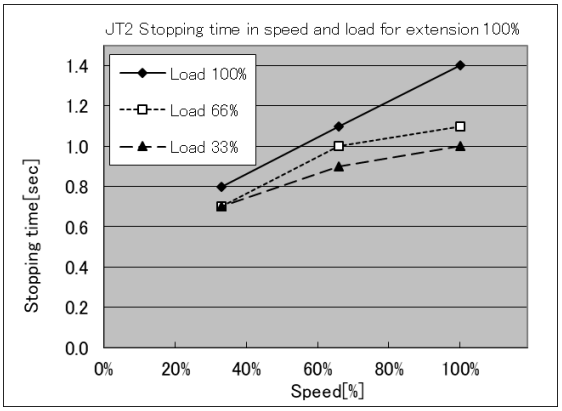


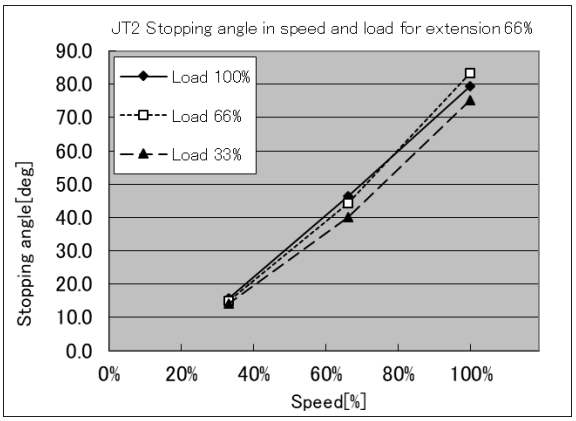


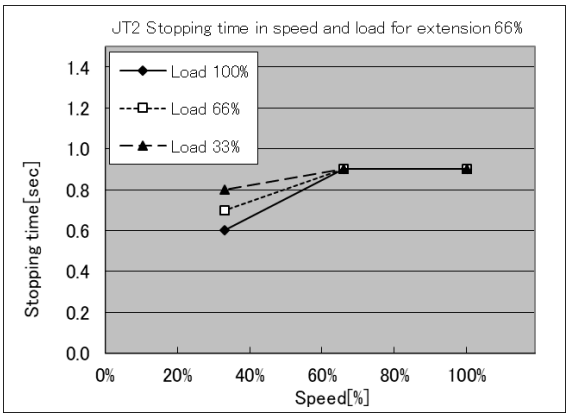


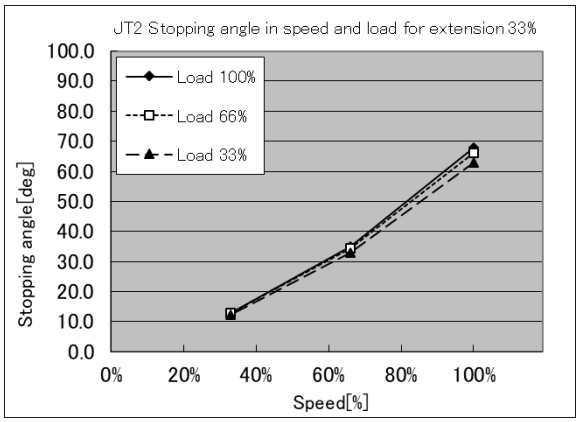
- Stopping angle and stopping time in category 1: JT2

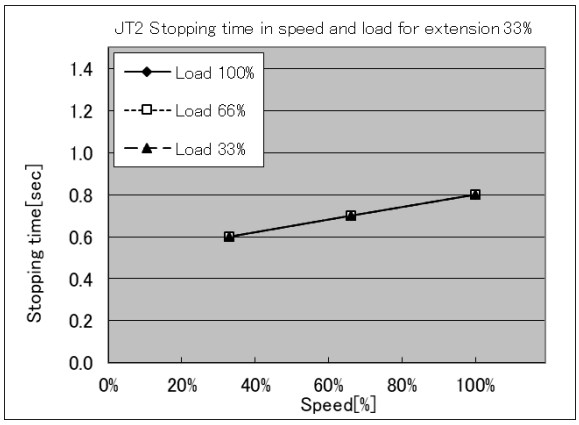




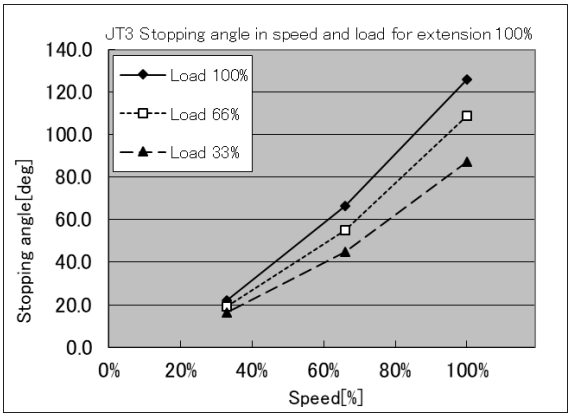


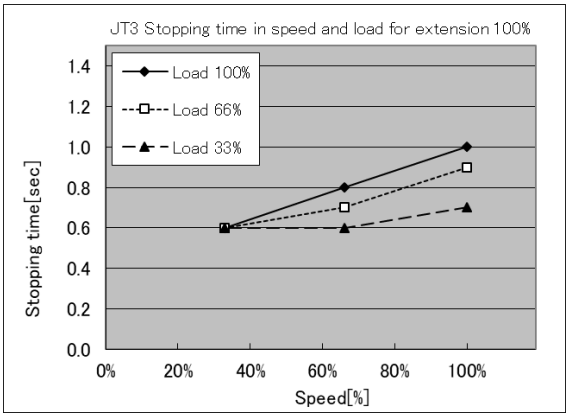






- Stopping angle and stopping time in category 1: JT3 (posture 100% only)





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