DESCRIPTION

TITLE OF INVENTION:

BINDING DEVICE AND BINDING SYSTEM

TECHNICAL FIELD

[0001] The present invention relates to a binding device that binds reinforcing bars with a wire, and a binding system including the binding device.

BACKGROUND ART

[0002] Reinforcing bars are used in concrete structures to improve strength, and are bound with wires to be prevented from deviating from prescribed positions during concrete pouring.

[0003] In the related art, there has been proposed a binding machine referred to as a reinforcing bar binding machine that is provided with a wire feed unit feeding a wire to a binding unit, winds the wire around two or more reinforcing bars, and twists the wire wound around the reinforcing bars to bind the two or more reinforcing bars with the wire.

[0004] There has been proposed a technique in which such a reinforcing bar binding machine is applied to equipment to be installed and used (for example, see Patent Literature 1).

CITATION LIST

PATENT LITERATURE

[0005] Patent Literature 1: JP2023-105958A

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] When the reinforcing bar binding machine is applied to equipment to be installed and used, it is conceivable to increase an amount of wire to be housed by increasing the size of the reel around which the wire is wound compared to a reel having a size that can be loaded into a previous reinforcing bar binding machine.

[0007] However, when the reel larger than the reel having a size that can be loaded into a previous reinforcing bar binding machine is used, a load required for feeding the wire increases due to the increase in size of the reel, and there is a possibility that the wire cannot be sufficiently fed to the binding unit only by the wire feed unit provided in the reinforcing

bar binding machine. For this reason, when the reel larger than the reel having a size that can be loaded into a previous reinforcing bar binding machine is used, it is necessary to form a sufficient slack between the reel and the binding machine so that a necessary amount of wire for binding the reinforcing bars can be reliably drawn or the wire is fed to the binding unit.

[0008] Therefore, Patent Literature 1 discloses binding equipment in which a reel housing unit that houses a reel around which a wire is wound is configured to be independent of a reinforcing bar binding machine, and which includes a wire drawing mechanism that draws the wire from the reel housed in the reel housing unit and a transfer robot that moves the reinforcing bar binding machine to a binding position.

[0009] The binding equipment described in Patent Literature 1 has a configuration in which the transfer robot moves the reinforcing bar binding machine to a binding position by moving the reinforcing bar binding machine in a direction toward and a direction away from an arrangement surface of the reinforcing bars.

[0010] However, in the binding equipment described in Patent Literature 1, since the reinforcing bar binding machine raises and lowers independently of the wire drawing mechanism, an orientation in which the wire enters the reinforcing bar binding machine changes due to an operation of raising and lowering the reinforcing bar binding machine. Accordingly, a load applied to the wire feed unit of the reinforcing bar binding machine fluctuates, which causes a failure in wire feeding by the wire feed unit.

[0011] The present invention has been made to solve such a problem, and an object of the present invention is to provide a binding device and a binding system capable of reliably drawing a necessary amount of wire for binding reinforcing bars and preventing a change in orientation of the wire entering a binding machine.

SOLUTION TO PROBLEM

[0012] In order to solve the above problem, the present invention provides a binding device including: a binding machine configured to bind a plurality of arranged reinforcing bars with a wire; and a slack forming unit configured to form a slack in a wire between a reel around which the wire supplied to the binding machine is wound and the binding machine, in which the binding machine includes a binding unit configured to bind the reinforcing bars with the wire and a wire feed unit configured to feed the wire to the binding unit, and the binding machine and the slack forming unit are configured to be integrally movable.

[0013] In addition, the present invention provides a binding system including: a binding device; and a moving body configured to move the binding device, in which the binding

device includes a binding machine configured to bind a plurality of arranged reinforcing bars with a wire, a slack forming unit configured to form a slack in a wire between a reel around which the wire supplied to the binding machine is wound and the binding machine, and a reel housing unit housing the reel, the binding machine includes a binding unit configured to bind the reinforcing bars with the wire and a wire feed unit configured to feed the wire to the binding unit, and the binding machine and the slack forming unit are configured to be integrally movable.

[0014] In the present invention, a slack portion is formed in the wire between the binding machine and the reel by an operation of the slack forming unit, and the slack portion of the wire enters the wire feed unit of the binding machine.

ADVANTAGEOUS EFFECTS OF INVENTION

[0015] According to the present invention, since the binding machine and the slack forming unit are configured to be integrally movable, the direction in which the slack portion of the wire formed by the slack forming unit enters the wire feed unit of the binding machine does not change in the operation of moving the binding device. Accordingly, the fluctuation of the load applied to the wire feed unit is prevented, and the occurrence of the failure in wire feeding by the wire feed unit is prevented.

BRIEF DESCRIPTION OF DRAWINGS

[0016] [FIG. 1A] FIG. 1A is a side view illustrating an example of a binding device according to the present embodiment;

[FIG. 1B] FIG. 1B is a side view illustrating the example of the binding device according to the present embodiment, with some components omitted from illustration;

[FIG. 1C] FIG. 1C is a perspective view illustrating the example of the binding device according to the present embodiment;

[FIG. 1D] FIG. 1D is a rear view illustrating the example of the binding device according to the present embodiment;

[FIG. 1E] FIG. 1E is a side view viewed from a back surface illustrating the example of the binding device according to the present embodiment;

[FIG. 2] FIG. 2 is an internal configuration diagram illustrating an example of a reinforcing bar binding machine as viewed from a side;

[FIG. 3A] FIG. 3A is a perspective view illustrating an example of a binding system according to the present embodiment;

[FIG. 3B] FIG. 3B is a perspective view illustrating the example of the binding system according to the present embodiment;

[FIG. 4A] FIG. 4A is a side view illustrating an example of an operation of the binding device according to the present embodiment;

[FIG. 4B] FIG. 4B is a side view illustrating the example of the operation of the binding device according to the present embodiment, with some components omitted from illustration;

[FIG. 5A] FIG. 5A is a side view illustrating an example of an operation of the binding device according to the present embodiment;

[FIG. 5B] FIG. 5B is a side view illustrating the example of the operation of the binding device according to the present embodiment, with some components omitted from illustration; and

[FIG. 6] FIG. 6 is a side view illustrating an example of a binding operation, with some components of the binding device omitted from illustration.

DESCRIPTION OF EMBODIMENTS

[0017] Hereinafter, embodiments of a binding device and a binding system according to the present invention will be described with reference to the drawings.

[0018] <Configuration Example of Binding Device According to Present Embodiment>

FIG. 1A is a side view illustrating an example of a binding device according to the present embodiment, and FIG. 1B is a side view illustrating the example of the binding device according to the present embodiment, with some components omitted from illustration. FIG. 1C is a perspective view illustrating the example of the binding device according to the present embodiment, FIG. 1D is a rear view illustrating the example of the binding device according to the present embodiment, and FIG. 1E is a side view viewed from a back surface illustrating the example of the binding device according to the present embodiment.

[0019] A binding device 100 includes a reinforcing bar binding machine 1 that binds intersections of reinforcing bars S arranged in a grid pattern with a wire W, a slack forming unit 2 that draws the wire W from a reel 20 and forms a slack in the wire W between the reinforcing bar binding machine 1 and the reel 20, and a reel housing unit 200 that houses the reel 20. The slack forming unit 2 may not have a function of drawing the wire W from the reel 20, as long as the slack can be formed.

[0020] FIG. 2 is an internal configuration diagram illustrating an example of a reinforcing

bar binding machine as viewed from a side. The reinforcing bar binding machine 1 is an example of a binding machine, feeds the wire W in a forward direction indicated by an arrow F, winds the wire W around the reinforcing bars S, feeds the wire W wound around the reinforcing bars S in a reverse direction indicated by an arrow R to wind the wire W around the reinforcing bars S and cut the wire W, and then twists the wire W to bind the reinforcing bars S with the wire W.

[0021] In order to implement the above functions, the reinforcing bar binding machine 1 includes a wire feed unit 3 that feeds the wire W, and wire guides 4 that guide the wire W. The reinforcing bar binding machine 1 includes a curl forming unit 5 that constitutes a path for winding the wire W fed by the wire feed unit 3 around the reinforcing bars S, and a cut unit 6 that cuts the wire W wound around the reinforcing bars S. The reinforcing bar binding machine 1 further includes a binding unit 7 that twists the wire W wound around the reinforcing bars S, and a driving unit 8 that drives the binding unit 7.

[0022] The wire feed unit 3 includes a pair of feed gears 30 that sandwich and feed the wire W. The wire feed unit 3 receives a rotation operation of a feeding motor (not illustrated), causing the feed gears 30 to rotate. Accordingly, the wire feed unit 3 feeds the wire W sandwiched between the pair of feed gears 30 along an extending direction of the wire W. In a configuration in which a plurality of, for example, two wires W are fed to bind the reinforcing bars S, the two wires W are fed in parallel.

[0023] In the wire feed unit 3, rotational directions of the feed gears 30 are switched by switching forward and reverse rotational directions of the feeding motor (not illustrated), and forward and reverse feed directions of the wires W are switched such that the wires W are fed in the forward direction indicated by the arrow F or in the reverse direction indicated by the arrow R.

[0024] The wire guides 4 are provided at predetermined positions upstream and downstream of the wire feed unit 3 with respect to the feed direction in which the wires W are fed in the forward direction. In the configuration in which two wires W are fed to bind the reinforcing bars S, the wire guide 4 provided upstream of the wire feed unit 3 regulates an orientation of the two wires W in a radial direction, arranges the two incoming wires W in parallel, and guides the two wires W between the pair of feed gears 30. The wire guide 4 provided downstream of the wire feed unit 3 regulates the orientation of the two wires W in the radial direction, arranges the two incoming wires W in parallel, and guides the two wires W into the cut unit 6 and the curl forming unit 5. In FIG. 2, the wire guide provided upstream

of the wire feed unit 3 is not illustrated.

[0025] The curl forming unit 5 includes a curl guide 50 that curls the wire W fed by the wire feed unit 3, and an inducing guide 51 that leads the wire W curled by the curl guide 50 to the binding unit 7. In the reinforcing bar binding machine 1, since a path of the wire W fed by the wire feed unit 3 is regulated by the curl forming unit 5, a trajectory of the wire W becomes a loop Ru as illustrated by a two-dot chain line in FIG. 2, and the wire W is wound around the reinforcing bars S.

[0026] The cut unit 6 includes a fixed blade portion 60 and a movable blade portion 61 that cuts the wire W in cooperation with the fixed blade portion 60. The cut unit 6 cuts the wire W by a rotation operation of the movable blade portion 61 with the fixed blade portion 60 as a fulcrum shaft. An operation of the binding unit 7 is transmitted to the movable blade portion 61 via the cut unit 6.

[0027] The binding unit 7 includes a locking member 70 that locks the wire W and a sleeve 71 that actuates the locking member 70. The driving unit 8 includes a twisting motor 80 and a speed reducer 81 that performs speed reduction and torque amplification.

[0028] The binding unit 7 is driven by the driving unit 8, causing the sleeve 71 to actuate the locking member 70 to lock the wire W. After the wire W is cut by the cut unit 6 in conjunction with the operation of the sleeve 71, the binding unit 7 twists the wire W by the rotation operation of the locking member 70 and the sleeve 71 to bind the reinforcing bars S.

[0029] The reinforcing bar binding machine 1 is provided with the binding unit 7 on a virtual straight line 10L along an axial direction of the twisting motor 80 illustrated by a one-dot chain line in FIG. 2. The reinforcing bar binding machine 1 is provided with the curl guide 50 and the inducing guide 51 at a lower end thereof, protruding from a main body 10, when an orientation of the virtual straight line 10L is set to be along an upper-lower direction.

[0030] The reinforcing bar binding machine 1 is provided with the wire feed unit 3 on one side in a direction intersecting the virtual straight line 10L, which is a direction intersecting the axial direction of the twisting motor 80.

[0031] Further, the binding device 100 is provided with the slack forming unit 2 on a side of the reinforcing bar binding machine 1 where the wire feed unit 3 is disposed, that is, on one side of the reinforcing bar binding machine 1 in the direction intersecting the virtual straight line 10L, which is the direction intersecting the axial direction of the twisting motor 80. The slack forming unit 2 forms a slack in the wire W between the reinforcing bar binding machine 1 and the reel 20.

[0032] The binding device 100 is provided with the reel housing unit 200 above the reinforcing bar binding machine 1 in a direction along which the virtual straight line 10L extends, which is a direction along the axial direction of the twisting motor 80.

[0033] The reel housing unit 200 houses the reel 20 such that the reel 20 is rotatable and detachable, on which the elongated wire W is wound to be fed out. Examples of the wire W include a wire formed of a plastically deformable metal wire, a wire having a metal wire covered with resin, or a stranded wire.

[0034] In a configuration in which the reinforcing bar binding machine 1 binds the reinforcing bars S with one wire W, the reel housing unit 200 houses one reel 20 wound with one wire W and is configured to allow the reel 20 to draw one wire W while rotating. In a configuration in which the reinforcing bar binding machine 1 binds the reinforcing bars S with a plurality of wires W, the reel housing unit 200 houses a plurality of reels 20 corresponding to the number of the wires W and is configured to allow the reels 20 to draw a plurality of wires W while rotating. For example, in a configuration in which the reinforcing bar binding machine 1 binds the reinforcing bars S with two wires W, the reel housing unit 200 houses two reels 20 each wound with one wire W and is configured to allow the reels 20 to draw two wires W while rotating.

[0035] The reel housing unit 200 may include a brake portion that allows rotation of the reel 20 in a direction in which the wire W is drawn, and regulates the rotation of the reel 20 to a reverse direction.

[0036] The slack forming unit 2 includes a first slack forming unit 21, a second slack forming unit 22, a first guide portion 23, and a second guide portion 24.

[0037] The first slack forming unit 21 is an example of a slack forming mechanism part and includes a first slack forming roller 21a, a guide plate 21b, and guide members 21c and 21d.

[0038] The first slack forming roller 21a has a disk shape with a thickness greater than a diameter of the wire W, and has a guide surface 21f in contact with the wire W on an outer periphery of the disk. The first slack forming roller 21a is rotatably supported between a pair of guide plates 21b with a shaft 21g as a fulcrum.

[0039] The guide plates 21b are provided on both sides in an axial direction of the first slack forming roller 21a with the first slack forming roller 21a interposed therebetween. In the configuration in which the reinforcing bars S are bound with two wires W, the first slack forming rollers 21a are provided on both sides of one guide plate 21b, and the guide plate 21b

is provided on an outer side of each of the first slack forming rollers 21a.

[0040] The guide member 21c is provided to face the guide surface 21f of the first slack forming roller 21a in a path of the wire W entering the first slack forming unit 21 from the first guide portion 23. The guide member 21c is provided between the pair of guide plates 21b, for example, in a form of a cylindrical member that extends in a direction intersecting the guide plate 21b.

[0041] The guide member 21d is provided in a path of the wire W coming out of the first slack forming unit 21. The guide member 21d is provided between the pair of guide plates 21b, for example, in a form of a roller rotatable about a shaft 21h as a fulcrum.

[0042] The guide member 21c and the shaft 21h of the guide member 21d also function as a spacer that defines an interval between the pair of guide plates 21b.

[0043] The guide plate 21b covers at least a part of the side of the first slack forming roller 21a and at least a part of the sides of the guide members 21c and 21d, and has a shape capable of supporting the first slack forming roller 21a and the guide members 21c and 21d.

[0044] The second slack forming unit 22 is an example of the slack forming mechanism part and includes a second slack forming roller 22a, a guide plate 22b, and guide members 22c and 22d.

[0045] The second slack forming roller 22a has a disk shape with a thickness greater than the diameter of the wire W, and has a guide surface 22f in contact with the wire W on an outer periphery of the disk. The second slack forming roller 22a is rotatably supported between a pair of guide plates 22b with a shaft 22g as a fulcrum.

[0046] The guide plates 22b are provided on both sides in an axial direction of the second slack forming roller 22a with the second slack forming roller 22a interposed therebetween. In the configuration in which the reinforcing bars S are bound with two wires W, the second slack forming rollers 22a are provided on both sides of one guide plate 22b, and the guide plate 22b is provided on an outer side of each of the second slack forming rollers 22a.

[0047] The guide member 22c is provided in a path of the wire W entering the second slack forming unit 22 from the first slack forming unit 21. The guide member 22c is provided between the pair of guide plates 22b, for example, in a form of a roller rotatable about a shaft 22h as a fulcrum.

[0048] The guide member 22d is provided to face the guide surface 22f of the second slack forming roller 22a in a path of the wire W coming out of the second slack forming unit 22. The guide member 22d is provided between the pair of guide plates 22b, for example, in a

form of a cylindrical member that extends in a direction intersecting the guide plate 22b.

[0049] The guide member 22c and the shaft 22h of the guide member 22d also function as a spacer that defines an interval between the pair of guide plates 22b.

[0050] The guide plate 22b covers at least a part of the side of the second slack forming roller 22a and at least a part of the sides of the guide members 22c and 22d, and has a shape capable of supporting the second slack forming roller 22a and the guide members 22c and 22d.

[0051] The first guide portion 23 is provided between the reel 20 and the first slack forming unit 21. In the first guide portion 23, the wire W passes between a pair of guide plates 23a, and a path through which the wire W drawn from the reel 20 passes is directed toward the first slack forming unit 21.

[0052] The binding device 100 may include a guide portion 26 that forms a path through which the wire W passes between the reel 20 and the first guide portion 23. In the configuration in which the reinforcing bars S are bound with two wires W, the first guide portion 23 and the guide portion 26 are provided corresponding to each reel 20. The guide portion 26 guides the two wires W such that a distance between the paths through which the two wires W pass gradually narrows from each reel 20 toward the first guide portions 23, in order to accommodate a difference between a distance between the two reels 20 and a distance between the two first guide portions 23.

[0053] The second guide portion 24 is provided between the second slack forming unit 22 and the reinforcing bar binding machine 1. The second guide portion 24 may include a brake portion that allows passage of the wire W during the operation of feeding the wire W by the wire feed unit 3, and regulates the passage of the wire W during the operation of forming a slack in the wire W by the slack forming unit 2.

[0054] The binding device 100 includes a first movement guide portion 21i that guides movement of the first slack forming unit 21, a second movement guide portion 22i that guides movement of the second slack forming unit 22, and a driving unit 25 that moves the first slack forming unit 21 and the second slack forming unit 22.

[0055] The first movement guide portion 21i guides the first slack forming unit 21 to be movable in a direction along a feed path WL of the wire W entering the reinforcing bar binding machine 1, which is defined by the wire feed unit 3, the wire guide 4, and the like. The second movement guide portion 22i guides the second slack forming unit 22 to be movable in the direction along the feed path WL of the wire W entering the reinforcing bar

binding machine 1. The second movement guide portion 22i supports the second slack forming unit 22 such that the guide surface 22f of the second slack forming roller 22a is positioned on an extension line of the feed path WL of the wire W entering the reinforcing bar binding machine 1, which is defined by the wire feed unit 3, the wire guide 4, and the like.

[0056] The driving unit 25 includes a pair of pulleys 25a and 25b, a belt 25c wound around the pulleys 25a and 25b, and a motor 25d that drives the pulley 25a. The driving unit 25 includes a first connecting portion 25e that connects the first slack forming unit 21 and the belt 25c, and a second connecting portion 25f that connects the second slack forming unit 22 and the belt 25c.

[0057] The pulley 25a is provided on a side closer to the reinforcing bar binding machine 1 in the movement direction of the first slack forming unit 21 and the second slack forming unit 22. The pulley 25b is provided on a side away from the reinforcing bar binding machine 1 in the movement direction of the first slack forming unit 21 and the second slack forming unit 22. The belt 25c extends in the movement direction of the first slack forming unit 21 and the second slack forming unit 22. The first connecting portion 25e is connected to one side of the belt 25c extending between the pair of pulleys 25a and 25b, and the second connecting portion 25f is connected to the other side of the belt 25c extending between the pair of pulleys 25a and 25b.

[0058] One side and the other side of the belt 25c extending between the pair of pulleys 25a and 25b move in opposite directions to each other when the pulley 25a is rotated by being driven by the motor 25d. Accordingly, depending on the direction of rotation of the motor 25d, the first slack forming unit 21 and the second slack forming unit 22 move in a direction toward each other and a direction away from each other.

[0059] The wire W drawn from the reel 20 extends laterally with respect to the reinforcing bar binding machine 1 in the direction intersecting the axial direction of the twisting motor 80, and the path thereof is changed toward the slack forming unit 2 by the first guide portion 23. The path of the wire W passing through the slack forming unit 2 is changed toward the wire feed unit 3 of the reinforcing bar binding machine 1 by the second slack forming roller 22a.

[0060] In the binding device 100, the reinforcing bar binding machine 1 is attached to a binding machine support portion 101, and a reel housing unit 200 is attached to a housing unit support portion 102. The binding machine support portion 101 is attached to the housing unit support portion 102. Further, in the binding device 100, the slack forming unit 2 is attached to

a slack forming unit support portion 103. In the binding device 100, the housing unit support portion 102 and the slack forming unit support portion 103 are attached to a support portion 104.

[0061] In the binding device 100, the support portion 104 is provided above the reinforcing bar binding machine 1 and the reel housing unit 200 in the axial direction of the twisting motor 80, and an attachment portion 105 to which the robotic arm 300 is attached is provided on the support portion 104.

[0062] In the slack forming unit 2, the first slack forming unit 21, the second slack forming unit 22, and the driving unit 25 are provided on one side of the slack forming unit support portion 103, and a control unit 250 of the driving unit 25 and the like are provided on the other side of the slack forming unit support portion 103. The control unit 250 includes a control board (not illustrated), a board housing unit 250a that houses the control board, and the like.

[0063] As illustrated in FIG. 2, the reinforcing bar binding machine 1 is provided with the binding unit 7 on the virtual straight line 10L along the axial direction of the twisting motor 80. In the binding device 100, as illustrated in FIG. 1A, the attachment portion 105 is provided on the virtual straight line 10L. Accordingly, in the binding device 100, the binding unit 7 and the attachment portion 105 are provided on the same virtual straight line 10L. Therefore, when the orientation of the reinforcing bar binding machine 1 is set along an upper-lower direction such that the curl forming unit 5 faces downward, the binding unit 7 is provided vertically below the attachment portion 105.

[0064] Further, the reel housing unit 200 houses the reel 20 such that a rotation axis of the reel 20 is located on the virtual straight line 10L passing through the binding unit 7 and the attachment portion 105 when the binding device 100 is viewed from the side. When the binding device 100 is viewed from a direction orthogonal to the virtual straight line 10L, a position of the rotation axis of each reel deviates from the virtual straight line 10L depending on the number of reels to be used, but it is sufficient that a center of a line connecting rotation axes of all the reels to be used is located on the virtual straight line 10L, that is, the line connecting the rotation axes of the plurality of reels to be used is located on the virtual straight line 10L.

[0065] <Configuration Example of Binding System According to Present Embodiment>

FIGS. 3A and 3B are perspective views illustrating examples of a binding system according to the present embodiment. A binding system 301 includes the binding device 100

and the robotic arm 300. The binding system 301 includes an entire imaging unit 303, an individual imaging unit 305 provided in the binding device 100, and a gantry 311 on which the robotic arm 300 and the entire imaging unit 303 are provided.

[0066] In the description of the binding system 301, X, Y, and Z directions refer to directions illustrated in FIGS. 3A and 3B. The X, Y, and Z directions are orthogonal to each other, an XY plane is a substantially horizontal plane, and the Z direction is a direction substantially along a vertical direction.

[0067] The gantry 311 is formed in a rectangular parallelepiped shape elongated in the X direction, and includes four support columns 312 erected at four corners in the X direction and the Y direction, and a plurality of beams 313 bridged in the X direction and the Y direction at upper ends of the support columns 312.

[0068] In an area inside the gantry 311, a substantially half portion on one side (right side in FIGS. 3A and 3B) in the X direction is an imaging area E1 in which imaging by the entire imaging unit 303 is performed, and a half portion on the other side (left side in FIGS. 3A and 3B) is a binding area E2 in which a binding operation by the robotic arm 300 and the binding device 100 is performed.

[0069] In the binding system 301, a workpiece B in which a plurality of reinforcing bars S are arranged in a grid pattern is held by a workpiece holding unit 302. The workpiece holding unit 302 holds the workpiece B and moves the held workpiece B between the imaging area E1 illustrated in FIG. 3A and the binding area E2 illustrated in FIG. 3B. Specifically, the workpiece holding unit 302 includes a holding table 321 that holds the workpiece B, a rail 322 that movably supports the holding table 321, and a driving motor (not illustrated) that drives the rail 322.

[0070] The holding table 321 is formed in a rectangular plate shape having four sides along the X direction and the Y direction. Support plates 321a that support the plurality of reinforcing bars S constituting the workpiece B are erected on the four sides of the holding table 321. Each of the support plates 321a has a plurality of U-shaped grooves 321b opening upward, and the reinforcing bars S are inserted into the U-shaped grooves 321b. The plurality of reinforcing bars S are arranged in a grid pattern along the X direction and the Y direction in a state where ends of the reinforcing bars S are inserted into the U-shaped grooves 321b of the support plates 321a.

[0071] The rail 322 is laid along the X direction and guides the holding table 321 in the X direction. The rail 322 according to the present embodiment is laid such that the holding table

321 (workpiece B) is movable at least between the imaging area E1 and the binding area E2. However, the rail 322 may be extended to an outside of the gantry 311, and the workpiece B may be movable to a work process before and after binding.

[0072] The entire imaging unit 303 images the entire workpiece B at once or images each of a plurality of divided areas. Specifically, the entire imaging unit 303 includes a first camera 331 disposed above the imaging area E1 and a movement mechanism 332 that movably supports the first camera 331.

[0073] The first camera 331 is disposed to face downward, and images the workpiece B held by the workpiece holding unit 302 from above in the imaging area E1. The first camera 331 is a compound-eye (for example, four-eye) stereo camera, and can acquire distance information in a depth direction (upper-lower direction) together with image information (monochrome image) on the XY plane. A sensor type or the like of the first camera 331 is not particularly limited as long as the first camera 331 can acquire the distance information (depth information) together with the image information.

[0074] The movement mechanism 332 includes a Y direction slider 333 extending along the Y direction. The Y direction slider 333 is bridged over the beams 313 along the X direction and is supported by the beams 313 to be movable in the X direction. The first camera 331 is suspended from the Y direction slider 333 to be movable in the Y direction. The movement mechanism 332 is driven by a driving source (not illustrated) to cause the first camera 331 to move to a predetermined position (XY coordinates).

[0075] The robotic arm 300 is an example of a moving body, is supported by the movement mechanism 346, and causes the binding device 100 and the individual imaging unit 305 to move to desired positions in the binding area E2.

[0076] The movement mechanism 346 includes Y direction sliders 346a bridged over the beams 313 of the gantry 311. The Y direction sliders 346a cause the robotic arm 300 to move in the Y direction. The movement mechanism 346 may include, for example, a mechanism that causes the robotic arm 300 to move in the X direction. In addition, when an operation range of the robotic arm 300 can cover the entire binding area E2 without depending on the movement mechanism 346, the movement mechanism 346 may not be provided.

[0077] The robotic arm 300 is a suspended multi-joint robot, and is installed downward on the Y direction sliders 346a bridged over the beams 313 in the binding area E2. Specifically, the robotic arm 300 includes a base 341, a plurality of arms 342, an end effector 343, and a plurality of joints 344. The robotic arm 300 is not limited to the multi-joint robot.

[0078] The plurality of arms 342 are coupled in series to each other with the base 341 as a proximal end. The base 341 is supported by the Y direction sliders 346a of the movement mechanism 346 and is movable in the Y direction.

[0079] The plurality of joints 344 pivotably couple the base 341, the plurality of arms 342, and the end effector 343. Each joint 344 is provided with a motor (not illustrated), which is driven by the motor to rotate.

[0080] The end effector 343 is coupled to distal ends of the plurality of arms 342. The end effector 343 supports the individual imaging unit 305 and also supports the binding device 100 via the attachment portion 105.

[0081] The individual imaging unit 305 is mounted on a distal end of the robotic arm 300 and individually images the intersections P of the reinforcing bars S as binding objects in the binding area E2 with a resolution higher than that of the imaging by the entire imaging unit 303. Specifically, the individual imaging unit 305 includes a second camera 351, an illumination unit 353, and an elevator motor (not illustrated).

[0082] The second camera 351 is attached downward to the end effector 343 of the robotic arm 300, and images the intersections P of the reinforcing bars S as the binding objects from above. The second camera 351 is driven by an elevator motor (not illustrated), and moves in the upper-lower direction with respect to the end effector 343. The second camera 351 is, for example, an RGB camera, and acquires image information (color image) of the intersections P as the binding objects. A sensor type and the like of the second camera 351 are not particularly limited as long as the second camera 351 can acquire an image (signal information) of at least one intersection P.

[0083] The illumination unit 353 illuminates an imaging object of the second camera 351.

[0084] The binding system 301 moves the workpiece B to the imaging area E1, images the entire workpiece B with the first camera 331 of the entire imaging unit 303, and acquires the position information of the intersections P of the reinforcing bars S. When the binding system 301 acquires the position information of the intersections P of the reinforcing bars S and the like, the binding system 301 moves the workpiece B to the binding area E2 and moves the binding device 100 to positions of the intersections P of the binding objects by the robotic arm 300 based on the position information of the intersections P of the reinforcing bars S and the like.

[0085] When the binding device 100 is moved to the positions of the intersections P of the binding objects, the binding system 301 images the intersections P of the binding objects with

the second camera 351 of the individual imaging unit 305 and acquires the image information of the intersections P of the binding objects. Then, the binding system 301 acquires position information or the like with higher accuracy than the position information of the intersections P acquired by the entire imaging unit 303 from the image information acquired by the individual imaging unit 305, moves the binding device 100 by the robotic arm 300, and performs the binding operation.

[0086] <Operation Example of Binding Device According to Present Embodiment>

FIGS. 4A and 5A are side views illustrating examples of an operation of the binding device according to the present embodiment, and FIGS. 4B and 5B are side views illustrating the examples of the operation of the binding device according to the present embodiment, with some components omitted from illustration.

[0087] In the binding device 100, depending on the direction of rotation of the motor 25d, the first slack forming unit 21 and the second slack forming unit 22 move from a standby position illustrated in FIGS. 1A and 1B and the like to a slack formation position illustrated in FIGS. 4A and 4B in the direction away from each other, and move from the slack formation position illustrated in FIGS. 4A and 4B to the standby position illustrated in FIGS. 5A and 5B in the direction toward each other.

[0088] In the binding device 100, when the first slack forming unit 21 moves from the standby position to the slack formation position, the first slack forming roller 21a moves in a direction toward the reinforcing bar binding machine 1. When the first slack forming roller 21a moves in the direction toward the reinforcing bar binding machine 1, the guide surface 21f comes into contact with the wire W, and pulls the wire W at a site in contact with the guide surface 21f in the direction toward the reinforcing bar binding machine 1.

[0089] In the binding device 100, when the second slack forming unit 22 moves from the standby position to the slack formation position, the second slack forming roller 22a moves in a direction away from the reinforcing bar binding machine 1. When the second slack forming roller 22a moves in the direction away from the reinforcing bar binding machine 1, the guide surface 22f comes into contact with the wire W, and pulls the wire W at a site in contact with the guide surface 22f in the direction away from the reinforcing bar binding machine 1.

[0090] The wire W entering the reinforcing bar binding machine 1 is sandwiched by the pair of feed gears 30. The pair of feed gears 30 are prevented from being rotated by an external force when driving of the feeding motor (not illustrated) is stopped. Accordingly, even when the second slack forming roller 22a moves in the direction away from the

reinforcing bar binding machine 1 and a force for pulling the wire W at the site in contact with the guide surface 22f in the direction away from the reinforcing bar binding machine 1 is applied, the wire W is prevented from being drawn in the direction in which the wire W comes out from between the pair of feed gears 30.

[0091] The path of the wire W drawn from the reel 20 is changed toward the slack forming unit 2 by the first guide portion 23 between the reel 20 and the first slack forming roller 21a. Accordingly, the first slack forming roller 21a moves in the direction toward the reinforcing bar binding machine 1, and the wire W at the site in contact with the guide surface 21f is pulled in the direction toward the reinforcing bar binding machine 1, so that a force for drawing the wire W from the reel 20 is applied.

[0092] In addition, the second slack forming roller 22a moves in the direction away from the reinforcing bar binding machine 1, and the wire W at the site in contact with the guide surface 22f is pulled in the direction away from the reinforcing bar binding machine 1, so that the force for drawing the wire W from the reel 20 is applied via the first slack forming roller 21a.

[0093] The reel 20 is rotatable when the force for drawing the wire W is applied. Accordingly, when the first slack forming roller 21a moves in the direction toward the reinforcing bar binding machine 1 and the second slack forming roller 22a moves in the direction away from the reinforcing bar binding machine 1, the wire W is drawn from the reel 20.

[0094] In the binding device 100, when the first slack forming unit 21 moves from the slack formation position to the standby position, the first slack forming roller 21a moves in the direction away from the reinforcing bar binding machine 1. When the first slack forming roller 21a moves in the direction away from the reinforcing bar binding machine 1, the guide surface 21f separates from the wire W. Further, in the binding device 100, when the second slack forming unit 22 moves from the slack formation position to the standby position, the second slack forming roller 22a moves in the direction toward the reinforcing bar binding machine 1. When the second slack forming roller 22a moves in the direction toward the reinforcing bar binding machine 1, the guide surface 22f separates from the wire W. Accordingly, a slack portion WB is formed in the wire W between the reel 20 and the reinforcing bar binding machine 1.

[0095] The second slack forming unit 22 is supported by the second movement guide portion 22i such that the guide surface 22f is positioned on the extension line of the feed path

WL of the wire W entering the reinforcing bar binding machine 1, which is defined by the wire feed unit 3, the wire guide 4, and the like. Further, the second slack forming unit 22 is guided by the second movement guide portion 22i to be movable in the direction along the feed path WL of the wire W entering the reinforcing bar binding machine 1. Accordingly, the wire W entering the reinforcing bar binding machine 1 is prevented from being largely changed with respect to the feed path WL by the operation of the second slack forming unit 22 moving from the standby position to the slack formation position and the operation of moving from the slack formation position to the standby position.

[0096] When the first slack forming unit 21 moves from the slack formation position to the standby position, the guide member 21c guides the wire W between the pair of guide plates 21b. Accordingly, the movement of the wire W entering the first slack forming unit 21 in the axial direction of the first slack forming roller 21a is prevented by the pair of guide plates 21b. Therefore, the wire W entering the first slack forming unit 21 is prevented from being entangled with the first guide portion 23 or the like. In the configuration in which the reinforcing bars S are bound with two wires W, the two wires W are prevented from being entangled with each other in the slack forming unit 2.

[0097] The wire W coming out of the first slack forming unit 21 is guided between the pair of guide plates 21b by the guide member 21d. Accordingly, the movement of the wire W coming out of the first slack forming unit 21 in the axial direction of the first slack forming roller 21a is prevented by the pair of guide plates 21b. In addition, the movement of the wire W coming out of the first slack forming unit 21 toward the second slack forming unit 22 is prevented by the guide member 21d. Therefore, the wire W coming out of the first slack forming unit 21 is prevented from being entangled with the second slack forming unit 22 or the like. In the configuration in which the reinforcing bars S are bound with two wires W, the two wires W are prevented from being entangled with each other in the slack forming unit 2.

[0098] Further, the wire W entering the second slack forming unit 22 is guided between the pair of guide plates 22b by the guide member 22c. Accordingly, the movement of the wire W entering the second slack forming unit 22 in the axial direction of the second slack forming roller 22a is prevented by the pair of guide plates 22b. In addition, the movement of the wire W entering the second slack forming unit 22 toward the first slack forming unit 21 is prevented by the guide member 22c. Therefore, the wire W entering the second slack forming unit 22 is prevented from being entangled with the first slack forming unit 21 or the like. In the configuration in which the reinforcing bars S are bound with two wires W, the two wires

W are prevented from being entangled with each other in the slack forming unit 2.

[0099] The wire W coming out of the second slack forming unit 22 is guided between the pair of guide plates 22b by the guide member 22d. Accordingly, the movement of the wire W coming out of the second slack forming unit 22 in the axial direction of the second slack forming roller 22a is prevented by the pair of guide plates 22b. Therefore, in the configuration in which the reinforcing bars S are bound with two wires W, the two wires W are prevented from being entangled with each other in the slack forming unit 2.

[0100] FIG. 6 is a side view illustrating an example of a binding operation, with some components of the binding device omitted from illustration. As illustrated in FIGS. 5A and 5B, in the reinforcing bar binding machine 1, when a slack portion WB is formed in the wire W by the slack forming unit 2, the wire W is fed in the forward direction indicated by the arrow F by the wire feed unit 3 illustrated in FIG. 2 and is wound around the reinforcing bars S by the curl forming unit 5. In the operation of feeding the wire W in the forward direction indicated by the arrow F by the wire feed unit 3, as illustrated in FIG. 6, the slack portion WB of the wire W is fed. Accordingly, it is not necessary to rotate the reel 20 by the force for feeding the wire W in the forward direction indicated by the arrow F by the wire feed unit 3, the load applied to the wire feed unit 3 is reduced, and the occurrence of a failure in wire feeding by the wire feed unit 3 is prevented.

[0101] In order to wind the wire W wound around the reinforcing bars S on the reinforcing bars S, in the operation of feeding the wire W in the reverse direction indicated by the arrow R by the wire feed unit 3, a slack corresponding to the feed amount of the wire W in the reverse direction is formed. Accordingly, it is not necessary to rotate the reel 20 by the force for feeding the wire W in the reverse direction indicated by the arrow R by the wire feed unit 3, the load applied to the wire feed unit 3 is reduced, and the occurrence of a failure in wire feeding by the wire feed unit 3 is prevented.

[0102] In the binding device 100, after the slack forming unit 2 forms the slack portion WB corresponding to the amount of the wire W necessary for the operation of binding the reinforcing bars S by the reinforcing bar binding machine 1, the operation of binding the reinforcing bars S by the reinforcing bar binding machine 1 is performed. The slack forming unit 2 may be actuated during the operation of binding the reinforcing bars S by the reinforcing bar binding machine 1, and the slack portion WB corresponding to the amount of the wire W necessary for the next operation of binding the reinforcing bars S may be formed by the slack forming unit 2.

[0103] The binding device 100 is configured such that the reinforcing bar binding machine 1 and the slack forming unit 2 are integrally movable. Accordingly, the direction in which the slack portion WB of the wire W formed by the slack forming unit 2 enters the wire feed unit 3 of the reinforcing bar binding machine 1 does not change in the operation of moving the binding device 100 by the robotic arm 300. Therefore, the fluctuation of the load applied to the wire feed unit 3 is prevented, and the occurrence of the failure in the wire feeding by the wire feed unit 3 is prevented.

[0104] In addition, as compared with a case where the reinforcing bar binding machine 1 and the slack forming unit 2 are independently configured, the slack forming unit 2 can be provided closer to the reinforcing bar binding machine 1, and a path length through which the wire W passes can be reduced. Accordingly, it is possible to eliminate factors that cause the failure in the wire feeding.

[0105] Further, as compared with the case where the reinforcing bar binding machine 1 and the slack forming unit 2 are independently configured, it is possible to reduce a tolerance when the reinforcing bar binding machine 1 and the slack forming unit 2 are integrally assembled, and it is possible to eliminate factors that cause the failure in wire feeding due to accuracy between the reinforcing bar binding machine 1 and the slack forming unit 2.

[0106] In addition, since the slack forming unit 2 includes the driving unit 25 that drives the first slack forming unit 21 and the second slack forming unit 22 drawing the wire W wound on the reel 20, it is not necessary to, for example, raise and lower the reinforcing bar binding machine 1 in the operation of drawing the wire W from the reel 20. Accordingly, the drawing of the wire W does not depend on a distance between the reinforcing bar binding machine 1 and an arrangement surface of the reinforcing bars S.

[0107] Further, in the slack forming unit 2, the first slack forming unit 21, the second slack forming unit 22, and the driving unit 25 are provided on one side of the slack forming unit support portion 103, and the control unit 250 of the driving unit 25 and the like are provided on the other side of the slack forming unit support portion 103. Accordingly, by the operation of actuating the slack forming unit 2 to form the slack in the wire W and the operation of feeding the wire W by the wire feed unit 3, the wire W is prevented from coming into contact with the control unit 250 or the like, and the occurrence of malfunction of the slack forming unit 2 and the occurrence of the failure in wire feeding are prevented.

[0108] In addition, since the housing unit support portion 102 that supports the reel housing unit 200, the slack forming unit support portion 103 that supports the slack forming unit 2,

and the support portion 104 that supports the housing unit support portion 102 and the slack forming unit support portion 103 are provided, and the reel housing unit 200 and the slack forming unit 2 are integrally configured, it is possible to reduce the size of the binding device 100.

[0109] Further, since the binding machine support portion 101 that supports the reinforcing bar binding machine 1 is provided, and the binding machine support portion 101 is supported by the housing unit support portion 102, a relative position between the reinforcing bar binding machine 1 and the reel 20 does not change, and the wire W is not inadvertently drawn. Accordingly, the occurrence of the malfunction of the slack forming unit 2 and the occurrence of the failure in wire feeding due to excessive drawing of the wire W are prevented.

[0110] Further, in the binding device 100, the slack forming unit 2 is provided on a side where the wire feed unit 3 is provided with respect to the reinforcing bar binding machine 1. Accordingly, the path of the wire W entering the wire feed unit 3 from the slack forming unit 2 is prevented from crossing the binding unit 7 which is a movable component, and the wire W is prevented from being entangled with the binding unit 7 or the like. A space can be secured on a side opposite the side where the wire feed unit 3 is provided with respect to the reinforcing bar binding machine 1, and even when there is an obstacle in the vicinity of the binding device 100, the reinforcing bar binding machine 1 can be moved to a position of an intersection of the reinforcing bars S as the binding objects. When a camera or the like that images an intersection of the reinforcing bars S is provided, an installation location thereof can be secured.

[0111] Further, in the binding device 100, the attachment portion 105 for attaching the binding device 100 to the robotic arm 300 and the binding unit 7 of the reinforcing bar binding machine 1 are provided on the virtual straight line 10L along the axial direction of the twisting motor 80. Accordingly, when the orientation of the reinforcing bar binding machine 1 is set along the upper-lower direction such that the curl forming unit 5 faces downward, the binding unit 7 is provided vertically below the attachment portion 105. Therefore, at the position separated in the direction intersecting the virtual straight line 10L along the axial direction of the twisting motor 80, the weight of the twisting motor 80, the binding unit 7, and the like is prevented from being applied to the robotic arm 300 via the attachment portion 105, and the position of the reinforcing bar binding machine 1 is prevented from being deviated from the intersection of the reinforcing bars S as the binding objects due to the load

being biasedly applied to the robotic arm 300.

[0112] Further, the reel housing unit 200 houses the reel 20 such that the rotation axis of the reel 20 is located on the virtual straight line 10L passing through the binding unit 7 and the attachment portion 105 when the binding device 100 is viewed from the side. Accordingly, at the position separated in the direction intersecting the virtual straight line 10L along the axial direction of the twisting motor 80, the weight of the reel 20 is prevented from being applied to the robotic arm 300 via the attachment portion 105, and the position of the reinforcing bar binding machine 1 is prevented from being deviated from the intersection of the reinforcing bars S as the binding objects due to the load being biasedly applied to the robotic arm 300.

[0113] Since the first slack forming unit 21 and the second slack forming unit 22 move relative to each other, the slack forming unit 2 can secure the drawing amount of the wire W while preventing an increase in the movement amount of the first slack forming unit 21 and the second slack forming unit 22. If the wire can be sufficiently fed to the binding unit by the wire feed unit, that is, if the drawing amount of the wire W can be secured or the slack of the wire between the reel and the binding machine can be secured, the slack forming unit 2 may be configured such that one slack forming roller moves in a direction intersecting the path through which the wire W passes. In addition, since the reel housing unit 200 is provided with a reel driving unit such as a motor that rotates the reel 20, and the reel 20 is rotated by the driving of the reel driving unit, the slack forming unit 2 may be configured to form a slack in the wire W between the reel 20 and the reinforcing bar binding machine 1.

[0114] The present application is based on Japanese Patent Application No. 2024-013034 filed on January 31, 2024, the contents of which are incorporated herein by reference.

INDUSTRIAL APPLICABILITY

[0115] According to the present disclosure, it is possible to provide a binding device and a binding system capable of reliably drawing a necessary amount of wire for binding reinforcing bars and preventing a change in orientation of the wire entering a binding machine.

REFERENCE SIGNS LIST

[0116] 100 binding device

101 binding machine support portion

102 housing unit support portion

103 slack forming unit support portion

104 support portion

105 attachment portion

1 reinforcing bar binding machine (binding machine)

2 slack forming unit

20 reel

200 reel housing unit

21 first slack forming unit (slack forming mechanism part)

21a first slack forming roller

21b guide plate

21c, 21d guide member

21f guide surface

21g shaft

21h shaft

21i first movement guide portion

22 second slack forming unit (slack forming mechanism part)

22a second slack forming roller

22b guide plate

22c, 22d guide member

22f guide surface

22g shaft

22h shaft

22i second movement guide portion

23 first guide portion

23a guide plate

24 second guide portion

25 driving unit

25a, 25b pulley

25c belt

25d motor

25e first connecting portion

25f second connecting portion

26 guide portion

250 control unit

250a board housing unit

300 robotic arm (moving body)

301 binding system

CLAIMS

[Claim 1]

A binding device comprising:

a binding machine configured to bind a plurality of arranged reinforcing bars with a wire; and

a slack forming unit configured to form a slack in a wire between a reel around which the wire supplied to the binding machine is wound and the binding machine, wherein

the binding machine includes a binding unit configured to bind the reinforcing bars with the wire and a wire feed unit configured to feed the wire to the binding unit, and

the binding machine and the slack forming unit are configured to be integrally movable.

[Claim 2]

The binding device according to claim 1, wherein

the slack forming unit includes a slack forming mechanism part configured to draw the wire wound around the reel, and a driving unit configured to drive the slack forming mechanism part.

[Claim 3]

The binding device according to claim 2, further comprising:

a slack forming unit support portion configured to support the slack forming unit, wherein

the slack forming unit support portion is provided with the slack forming mechanism part and the driving unit on one side and is provided with a control unit of the driving unit on the other side.

[Claim 4]

The binding device according to claim 3, further comprising:

a reel housing unit housing the reel;

a housing unit support portion configured to support the reel housing unit; and

a support portion configured to support the housing unit support portion and the slack forming unit support portion.

[Claim 5]

The binding device according to claim 4, further comprising:

a binding machine support portion configured to support the binding machine, wherein

the binding machine support portion is supported by the housing unit support portion.

[Claim 6]

The binding device according to claim 1, wherein

the slack forming unit includes a guide member configured to define a path through which the wire passes between the reel and the binding machine.

[Claim 7]

The binding device according to claim 1, wherein

the slack forming unit is provided on a side of the binding machine on which the wire feed unit is provided.

[Claim 8]

The binding device according to claim 1, further comprising:

an attachment portion attached to a moving body configured to move the binding device in a direction along an arrangement surface of the plurality of arranged reinforcing bars and in a direction toward and a direction away from the arrangement surface.

[Claim 9]

The binding device according to claim 8, wherein

the attachment portion is provided on a virtual straight line passing through the binding unit, and the binding unit is provided vertically below the attachment portion when an orientation of the binding machine is set along an upper-lower direction.

[Claim 10]

The binding device according to claim 8, wherein

a reel housing unit in which the reel is housed houses the reel on a virtual straight line passing through the attachment portion and the binding unit.

[Claim 11]

A binding system comprising:

a binding device; and

a moving body configured to move the binding device, wherein

the binding device includes:

a binding machine configured to bind a plurality of arranged reinforcing bars with a wire;

a slack forming unit configured to form a slack in a wire between a reel around which the wire supplied to the binding machine is wound and the binding machine; and

a reel housing unit housing the reel,

the binding machine includes a binding unit configured to bind the reinforcing bars with the wire and a wire feed unit configured to feed the wire to the binding unit, and

the binding machine and the slack forming unit are configured to be integrally movable.